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PILES 110 FT. LONG were recently used in rebuilding the fender piers for the Thames River swing bridge, at New London, Conn., built in 1889. North Carolina pine piles from 50 to 65 ft. long were spliced with spruce piles 35 to 45 ft. long to a length of 110 ft. About 400 piles altogether were driven. The deepest water being 50 ft., it was figured that the spruce splices would be well below bottom and free from the attacks of the teredo, and to preserve the pine piles above the bottom they were creosoted. The piles of the original piers built in 1889 were practically completely destroyed by the teredo. According to the Providence "Journal" many of the piles were eaten away until they were hardly capable of sustaining their own weight. Others were honeycombed until there was nothing left but a thin shell, and the investigations made by divers showed that not a pile driven in 1888-89 had escaped the jaws of the industrious teredo.

PROGRESS ON THE SIMPLON TUNNEL during the month of September is reported in the "Schweizerische Bauzeitung" as follows: The north heading advanced 518 ft., the south heading advanced 577 ft., therefore both headings in the aggregate 1,095 ft. The average number of men employed was 3,104, of whom 2,066 were employed within the tunnel. The material penetrated by the north heading was a slaty gneiss; the south heading advanced through calcareous micaschist and anhydrite, until at 5,327 km. (17,473 ft.) the slaty gneiss of Monte Leone was reached. The total depth reached by the headings up to the end of September is 25,873 ft. for the north heading and 17,584 ft. for the south heading, or a total of 43,457 ft.

NO DRINKING WATER in the public schools of Chicago has been the rule during the present school year and, after an investigation by three water specialists, a committee of the board of education has recommended that the supply remain shut off until the local board of health declares it to be safe. The specialists engaged were Messrs. John H. Long, F. Robert Zeit and Edward O. Jordan, who made chemical and bacterial analyses and inoculation tests of water from five school buildings, in districts supplied by as many lake tunnels. The specialists declared that the use of the water without sterilization could not be recommended, and that if sterilization was to be introduced, boiling would be the least expensive method available. They pointed out several local conditions that may be comforting or quite the reverse, according to the way the citizens of Chicago view the situation. Among these were the statements that the water was no worse the latter part of September, 1902, than it has been from time to time during the past 15 years; that the present pollution "is probably not a permanent condition, but will in a large measure disappear with the completion of the intercepting sewers," and that comparatively few children are guarded against impure water in their homes, so on considering how small a portion of their time is spent in school, "it is extremely doubtful whether any great measure of safety for a large proportion of the children would be secured by the sterilization of the water."

THE PRELIMINARY FILTER for the Lower Roxborough water purification plant, at Philadelphia, is to be built by the Maignen Filtration Co., 1310 Arch St., Philadelphia, under the specifications outlined on p. 281 of our issue of Oct. 9, 1902. The plant will have a capacity of 12,000,000 gallons a day, working at a rate of 1,377 gallons per sq. ft., or 60,000,000 gallons per acre. The contract price is $49,800, or $4,150 per 1,000,000 gallons, the city to furnish the foundations for the filters and the house to cover them. The water to be treated will be drawn from a 13,000,000-gallon subsiding reservoir, and the rough-filtered water will go by gravity to the new covered slow sand filters, some of which have been in operation for a few weeks. It is expected that, after this preliminary treatment, water can be filtered at the rate of 6,000,000 gallons a day. Mr. Wm. C. Haddock is Director of Public Works, and Mr. John W. Hill, M. Am. Soc. C. E., is Chief Engineer of the Bureau of Filtration.

THE RELATIONS OF PRIVATE FIRE SUPPLIES to the water-works upon which they are dependent is to be given further study by the New England Water-Works Association, through a new committee just appointed by Mr. Frank E. Merrill, of Somerville, Mass., President of the association. The members are as follows: Messrs. Frank H. Crandall, Superintendent Water-Works, Burlington, Vt.; Robt. J. Thomas, Superintendent Water-Works, Burlington, Vt., and Elbert Wheeler, Treasurer Knoxville (Tenn.) Water Co., 14 Beacon St., Boston, Mass. The report of a former committee on this subject was given in our issue of Sept. 18, 1902. The new committee, it is expected, will confer with like committees representing other water-works associations and also the insurance interests.

DAMAGES FOR INSUFFICIENT FIRE PROTECTION have been awarded against the Georgetown Water Co., of Georgetown, Ky. The suit was brought by Mrs. James E. Cantrill for $12,000 damages on account of the destruction of her residence in January, 1901. The award was for $6,000.——The city of Paris and the county of Bourbon, also in Kentucky, have brought suit for $100,000 against the Paris Water Co. for failure to furnish water to prevent the destruction of the Paris court house in October, 1901.

ELECTROLYSIS MAY BE DIMINISHED by periodical reversal of the current, according to experiments made by A. Larsen at the Copenhagen (Denmark) Technical College. Several lengths of pipe were buried in the ground with their ends separated and equal currents were passed through all the pieces. In some of them the direction of the current was maintained uniform, in some it was reversed at hourly intervals, while in others it was reversed every 24 hours. After some time the pieces of pipe were taken out and weighed. It was found that the loss of weight in the case of the pipes with daily reversal of current was only one-fourth as much as with those pipes in which the direction of the current was maintained constant; the loss of weight in the latter case was 30 times as great as where the current was reversed hourly. The pipes experimented with were 4 to 6 ins. in diameter, and currents of 0.121 to 0.341 amperes were used.

STREET RAILWAYS, ELECTRIC LIGHT AND POWER will be investigated by the the U. S. Census Office, and, it is said, a special volume will be published to give the results obtained.

THE CHICAGO-ST. LOUIS DRAINAGE CANAL SUIT may be dismissed without trial, permission to file a motion to that effect on Monday, Nov. 10, having been granted by the U. S. Supreme Court on Oct. 20. The petition for leave was made by Mr. William Springer, attorney for the State of Illinois and the Chicago Sanitary District. Mr. Springer stated that issues in the case were joined on May 27, 1901, but that "since that time an entire term of this court has intervened and no effort has been made by the complainant to further prosecute said cause or to sustain its said bill of complaint by testimony of any kind. Counsel for respondents respectfully insist, in view of the facts of record and the law applicable thereto, that their motion to dismiss for want of prosecution should be allowed."

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the Pennsylvania R. R. at New Florence, Pa., on Oct. 22. A passenger train ran into some wreckage from a small freight train accident and left the track. One person was killed in the wreck.

A DRAWBRIDGE ACCIDENT occurred on the line of the Southern Pacific Ry., at Morgan City, Ala., on Oct. 5. An eastbound freight train went off the track while crossing the bridge over the Atchafalaya River at that place, and partially wrecked the draw span of the bridge. No one was killed or injured, but four cars of the train were thrown into the river. As to the cause of the accident Mr. J. Kruttschnitt, General Manager of the Southern Pacific Co., informs us as follows:

The latches of the draw are interlocked with Hall electric disc signals; the draw was closed at the time of the accident, but the rails were not yet adjusted, nor was the bridge latched, and consequently the signals stood at danger. The locomotive and tender derailed and ran over the bridge, tearing up the floor and derailing six loaded cars, which were thrown against the trusses, wrecking one arm of the span. The bridge was of iron, erected in 1882, by the Phoenix Bridge Co.

ANOTHER WOODEN WATER TANK FAILED on Oct. 18, this one being located on a trestle above the main roof of Dobson's carpet mills, in Philadelphia. The tank was of cedar and, it is said, had been re-hooped only a few weeks ago. This is one of a number of similar failures within the past few weeks.

OIL AS LOCOMOTIVE FUEL will have entirely displaced coal on the Southern Pacific R. R. by December, 1903, it is said. Tests on one division have shown that for every 100 miles, 24 bbls. of oil are required, where 5 tons of coal are ordinarily used.

THE VALUE OF FUEL OIL COMPARED WITH COAL is given in considerable detail in a paper by Lieut. Charles L. Poor in the "Notes on Naval Progress" issued by the Office of Naval Intelligence at Washington. The Dutch torpedo boat "Pangrango," using 700 lbs. of oil per hour in addition to its regular consumption of 2,800 lbs. of coal, secured an added speed of two knots without making smoke. The North German Lloyd vessel, "Tanglin," burning oil only, secured a speed of one knot per hour greater than with coal and at less cost for fuel. She consumed 13 tons of oil daily, as against 18 tons of English and 20 tons of Japanese coal, and it required but one fireman in place of five. We may add that recent exhaustive comparative tests of Texas oil and coal made in a stationary boiler furnace by Prof. Denton, of Stevens Institute, Hoboken, N. J., showed that 1,360 lbs. of oil equaled 2,240 lbs. of coal.

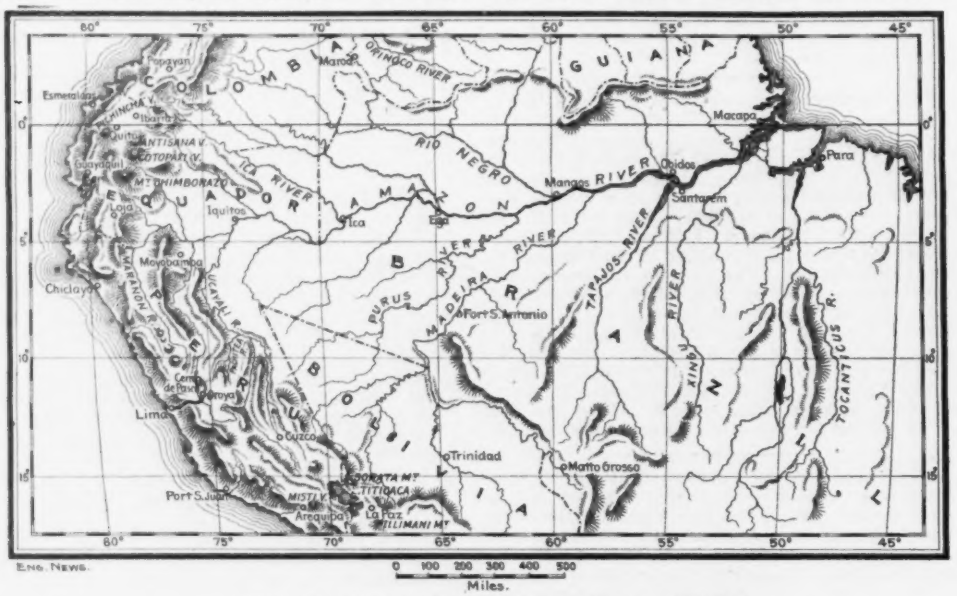
LIQUID AIR ENGINE EFFICIENCY is discussed by Prof. F. R. Allen, of Cornell University, in a paper, an abstract of which appears in "The Gas Engine," and as the result of tests he says: "The expenditure of 1 HP. continuously for one hour results in the production of just enough liquid air which, if utilized in its turn as a source of power in a perfect machine, would produce 1 HP. for one minute (1½% efficiency). The most efficient method of obtaining liquid air yet discovered would increase this last period of time to five minutes" (8% efficiency). These figures make apparent the absurdity of the claims made for liquid air as a motive power by Tripler and his lieutenants in the defunct Tripler Liquid Air Co.

AN ADDITIONAL POWER PLANT for the Twin City Rapid Transit Co., of St. Paul and Minneapolis, Minn., is being built, as the present stations have not sufficient capacity for the extensions and interurban lines proposed. The new plant will be operated by steam, and will have five units of 5,000 HP., or 9,000-HP. maximum capacity. The first of these is to be installed by July, 1903, and two more by January, 1904. The St. Anthony Falls water power plant furnishes from 2,000 to 9,000 HP., according to the stage of the river, but the average is usually about 3,000 to 4,000 HP. The Third Ave. steam plant at Minneapolis has a capacity of 4,000 HP., and is supplemented by two storage batteries of 1,500 HP. each, to help out the heavy loads at the rush hours. In St. Paul, the Selby Ave. station is of 1,000-HP. capacity, and the Hill power station, 3,000 HP.

PROGRESS IN STEAM TURBINE CONSTRUCTION and use was recently outlined in a paper by A. C. Parsons, and an abstract thereof appears in "The Marine Review and Marine Record," Oct. 9. The total of all compound parallel-flow turbines at work or on order for generating electricity amounts to 300,000 HP.; the total for propelling ten vessels is 83,000 HP. In generating electricity the steam turbine compares favorably with the steam engine in point of efficiency, while the first cost, the maintenance, oil and attendance are all less. The lowest consumption so far recorded has been 17.31 lbs. of steam per kilowatt hour, corresponding to about 10.2 lbs. of steam per indicated HP. per hour. In the Oct. 10 issue of "Steam Engineering" there is a report of tests made by Dean & Main, of Boston, on a 300-HP. De Laval steam turbine, showing a coal consumption of 13.94 lbs. per HP. per hour, using eight nozzles and superheated steam, which is about 9% more efficient than dry saturated steam.

AN OUT-OF-THE-WAY CORNER OF THE WORLD.

On Sept. 4, there sailed from New York the steamer "Alps" of the Hamburg-American Line, bound for Iquitos, Peru. If the reader looks on a South American map for Iquitos, however, he will find it located, not on the western coast, but far inland, east of the Andes, and on one of the main branches of the Amazon River. The "Alps" will therefore proceed southward to the mouth of the Amazon and will ascend that stream some 3,000 miles before she finally anchors at Iquitos. The voyage was expected to take from 35 to 40 days. This is said to be the first merchant vessel to sail directly for Iquitos from an American port. As many of our readers may recall, the U. S. light draft gunboat "Wilmington" ascended the Amazon as far as Iquitos in 1897.



SKETCH MAP OF ROUTE FROM LIMA TO IQUITOS.

We have recently received from an English contributor, Mr. H. Guillaume, F. R. G. S., an extended account of this little known but rapidly developing section of South America, accompanied by photographs, a number of which we reproduce herewith.

The source of our correspondent's information is Mr. Melville G. Clayton, an English engineer, who was entrusted with the task of delivering at Iquitos a steam launch built by the English firm of J. I. Thornycroft & Co., for a rubber merchant at Iquitos.

A few years ago Iquitos was a small fishing village; and it is the rubber industry which has brought it into commercial prominence and expanded its population until it now boasts of some 7,000 inhabitants, consisting chiefly of natives of Peru, cholos, or half-castes, Jews coming from Gibraltar, Morocco and Tangiers in considerable numbers; Germans, French and Italians, with but few Englishmen.

Port Chiclayo on the Ucayali River.

The Booth line of Liverpool steamers serves Iquitos monthly direct, calling en route at Continental ports, and bringing provisions, clothing, tools, machinery, and, in fact, all classes of imported goods. Little attention is given to cultivation, the collection of rubber being far more profitable, and the total export last year from the port being 4,000 tons, against 3,100 tons during the previous year. This total includes rubber from Manaos. As a ton of crude rubber may be worth $1,000 to $1,500, it will be seen that the value of the export trade is by no means inconsiderable.

The climate of Iquitos is humid and the average shade temperature for the year is about 87°. Nevertheless it is said to be not unhealthy, and there are few deaths from fevers.

The rubber traders of Iquitos own about 50 light-draft steam vessels which ply all through the network of rivers in this region and collect rubber from the natives. The purchase is by barter, and the traders carry all sorts of goods from a mirror to a gun to exchange with the natives for rubber. In fact, these imported goods form the currency of the country. A repair shop to care for these steamers is maintained by the government at Iquitos.

In order to reach Iquitos from the west coast of Peru, at Lima, the traveler goes by rail up the famous Oroya Ry., which crosses the Andes at an elevation of 15,645 ft. From its terminus a road has been built by the Peruvian engineer, J. Capelo, extending down the eastern slope of the Andes to the headwaters of the Pichis River, at the settlement called Bermudez. Here a light-draft steamer is taken, and in this craft a voyage is made down this stream 79 miles to its junction with the Pachitea, and down the latter stream 191 miles, till it joins the Ucayali River, one of the main streams that unite to form the Amazon. This river is then followed for 825 miles till Iquitos is reached.

In traveling from Lima eastward the postal time from Lima to the head of navigation at Bermudez is 7 days. The steamer voyage from here to Iquitos, 1,095 miles, takes 5 days, but ascending the stream against the current 13 days are required.

The rubber forests of this part of South America are far from being exhausted. Immense regions have never been touched, as they are inhabited by Indians so savage that the rubber gatherers will not venture into them. The pampas of the Sacramento on the left of the Pachitea are also untouched, as they are inhabited by the Cashibos, a race of cannibals. These Indians occasionally menace steamers passing up or down the Pachitea. The greatest profit in rubber gathering is from the Caucho tree (Castilloa elastica), which is cut down, as it yields milk from the entire trunk, while the Shiringa tree only yields it from between the bark and the wood. It is therefore not felled, but simply tapped. Groves of the Shiringa occur at intervals in the forests, the Caucheros making pathways from tree to tree to gather juice. The Castilloa when felled exudes juice for three or four days, the milk flowing [illegible] trench in the ground. Its coagulation takes [illegible] two days. This rubber never equals in [illegible] that of the Shiringa, neither is it so elas[illegible] good gatherer will extract daily from 50 [illegible] lbs. of milk. It is said that the Caucho tree [illegible] from its roots again, and in five or six years [illegible] be again cut down.

The Campas Indians are the most civiliz[illegible] any of the native tribes on the Ucayali. [illegible] are copper-colored, and are supposed to have [illegible] blood in their veins. They are good canoeists and [illegible] clever at hunting and fishing. They dress in cus[illegible] mas, a blouse or sack, which they weave [illegible] the fiber of the wild cotton tree found on all the [illegible] rivers. The cotton is spun on a little spindle made [illegible] from chouta wood cut in a slice a little thicker [illegible] than a match. On the bottom is the vertebra [illegible] of the paicha fish, and with this single instrument a coarse thread is made, which is woven into cusmas. The Campas Indians often make raids on the savage Cashibos and make slaves of the captives, selling them to the rubber gatherers who use them in their work. These captives are said to be docile, and do not care to return to join their own people again after living with the more civilized tribes.

Several attempts at colonization have been made in this region, but have been failures, chiefly on account of the irregular transportation service of the river steamers, which have to be depended on for the staples of food supply at the start. The soil is productive, and a large variety of tropical products can be raised. Herr Augustine, a German, who is manager of the state steamboat repair shop at Iquitos, has also successfully reared cattle, goats and sheep.

Port Bermudez, the Head of Navigation on the Pichis River.

THE PROPOSED STANDARDIZATION OF METHODS OF CHEMICAL ANALYSIS.*

By Bertram Blount,† F. I. C., F. G. S.

There has been evident of late years a tendency to apply the principle of standardization to matters and in directions differing considerably from those in which the advisability of erecting and enforcing a standard is generally conceded.

A Rubber Gatherer's Hut.

*Condensed from a paper read at the Belfast Meeting of the British Association for the Advancement of Science.

†Of the firm of Stanger & Blount, Chemical Laboratory and Testing Works, 2 Broadway, Westminster, S. W., London.

The commonest examples of standardization,* namely, that of weights, of measures and of money, have come into existence and are maintained by their manifest necessity; the lack of a standard in these matters would bring us perilously near barbarism.

It may also be maintained with some confidence that various mechanical standards are so convenient as to be practically necessities. Standard gages for wire and sheet have been used very freely. Standard screw threads have also been found desirable and a Section of this Association has endeavored to discover and formulate an ideal screw thread. Pending the fruition of their labors other

A GROUP OF CAMPOS INDIANS.

standards, for example the Whitworth and the gas thread, established themselves by common usage and mutual consent.

Passing from these simpler cases where standardization is universally conceded to be convenient to a consideration of the advisability of extending this principle to more complex matters, we enter into a region of polemic; the advantages of an artificial uniformity are less clear and the disadvantages become more easily discernible and are ultimately prominent.

Thus it may be debated—and the subject is even now in process of debate—whether structural metals should be molded into certain standard sizes and sections; whether an I-beam of a particular weight per yard should be of fixed dimensions; whether the thickness and contour of the head, web and flange of rail should be so standardized that an engineer specifying rails of a particular weight will have either to adopt the standard section or put down his own rolling plant. There is much to be said for such proceeding; by the use of few and fixed sizes production is undoubtedly cheapened and quickened and the establishment of metal standard sections would be welcomed by most manufacturers. But the engineer who is responsible for the ultimate behavior of the material is by no means so sure of the advantages thus set forth. He is aware that a standard section will not be best in every case and must from the nature of things be regarded as a compromise and he may, singular as it must appear in these days of collective activity, extending even to the realm of thought, actually prefer his own judgment to the combined wisdom of a number of other people.

Proceeding from merchantable products to technical processes our legitimate doubt as to the value of standardization becomes sensibly more acute. It may be right and proper to establish a standard rail section, but shall there also be a standard test specimen by which the mechanical quality of the metal may be ascertained? Must the form of testing machine in which the specimen is broken equally be defined? Shall the rate at which the load is run on be fixed by rule? Such matters have been mooted and discussed for years by various technical associations, but nothing that can be regarded as an accepted standard has been evolved from these debates.

A particular disadvantage attaching to the standardization of methods of mechanical testing is that already there is a disposition to rely too completely on stereotyped tests and not to consider intelligently what it is that it is desired to ascertain.

If the difficulty of accepting the principle of standardization is considerable in the matter of mechanical testing, it becomes still greater in the case of chemical analysis.

In mechanical testing it is recognized that the values obtained for strength in tension and compression, for elongation of a ductile test piece, for resistance to shock and the like are appreciably influenced by the conditions of the test and in consequence there is something to be said in favor of standard methods of applying the tests. But there is no such justification for the adoption of standard methods in chemical analysis where the object in view is the determination in a given material of a definite substance; in such a case all methods which are chemically sound must give the same result.

But notwithstanding these obvious facts a desire has arisen in some quarters for the formulation of standard methods of chemical analysis. A proposition of this sort was put before the Society of Chemical Industry by Professor Lunge in the year 1884, and in the face of an evident conflict of opinion it became necessary to appoint a committee to consider the whole question. I have not been able to find that any report by this committee was published.

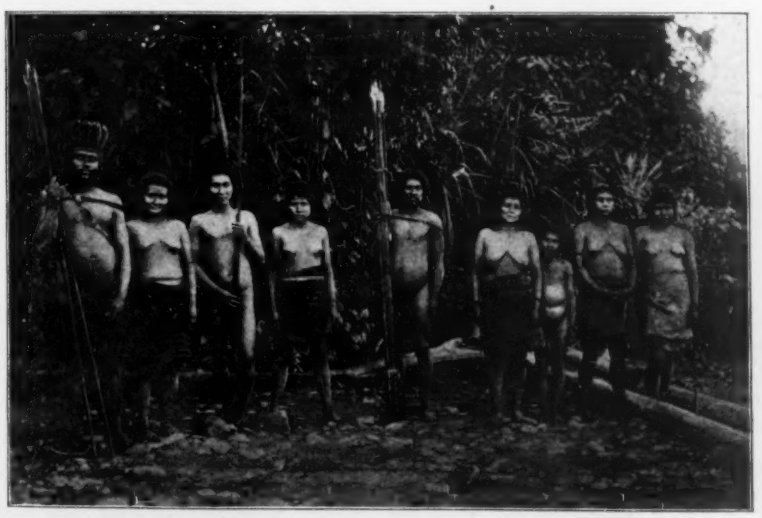
About the same time, now nearly 20 years ago, the Society of Public Analysts occupied themselves with a similar subject. The methods of water analysis were discussed and recommendations for a standard process were formulated. A like course was adopted for the analysis of milk and some years later for the detection of butter in margarine by the Reichert-Wollny process.

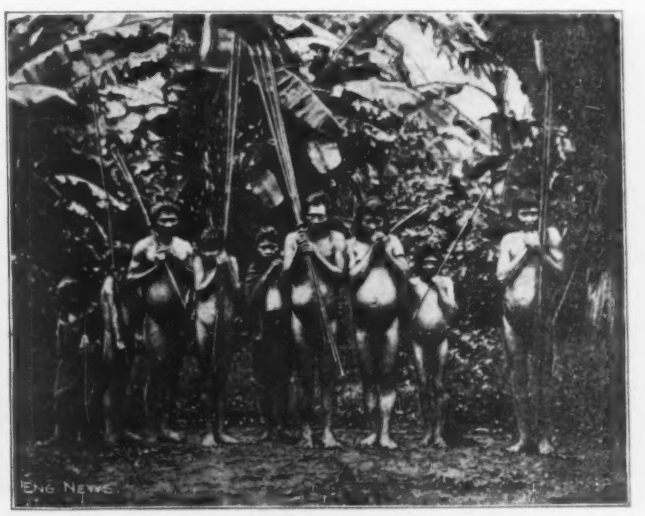
It will be observed that in all these cases the substances to be examined are natural products of indeterminate composition and that the methods for their examination are of the nature of empirical tests rather than of analysis proper. Such tests are often of the highest importance and utility for practical purposes, and from their nature are best performed under standard conditions, but they must not be confused with actual chemical analysis which is under no such obligation to rule.

At the meeting of the British Association, held in Bath in 1888, a committee was appointed "to consider the best methods of establishing international standards for the analysis of iron and steel." The initiation of this investigation appears to have been due to Prof. J. W. Langley, who undertook the preparation of the necessary samples. Other national committees were invited to join in the work and after some years certain of those committees reported. At an early stage of the proceedings the British Committee defined the object of the inquiry as the provision and preservation of specimens of iron and steel of a composition most carefully ascertained; these were intended to serve as standards whereby the accuracy of any given process or any given worker might be checked. It will be observed that there is here no word of a standard method of analysis; the members of the committee were to be free to use the method they thought proper and the results alone were to be standard.

But the members of the American committee, however, seem to have held a different object in view; they applied themselves to the examination of methods and especially of those for the determination of carbon. It may be conjectured that their objective was the provision of a standard method, but this aim was not attained and no subsequent attempt in the domain of steel analysis has met with greater success.

But the idea, although not realized, was by no means dead. Dr. C. B. Dudley, of the Pennsylvania R. R., in 1893, discussed the causes of discrepancy between the results of different chemists and advocated the use of





INDIANS OF THE NEAYALI RIVER DISTRICT.

standard methods for avoiding these discrepancies. Quite recently (in 1901) a committee of the New York Section of the Society of Chemical Industry approached the same subject in the same spirit and has reported in favor of a standard method of analysis for cement and cement materials. I had the honor in May last of reading a paper before this body in which I ventured to criticize the method in detail, and to dissent from the acceptance of a standard method.

These criticisms and objections were very frankly and fairly received and discussed, and it may be hoped that the discussion will induce some of those who were perhaps overready to accept standardization on its superficial merits to consider its real and weighty disadvantages and

*"Standardization" has so imposing and attractive a sound that it is often implicitly understood that the standard is the best thing of its kind; this is by no means the case, it is only a fixed thing.

to confine their activity to those branches of analytical work in which some form of standardization is admittedly useful.

There are in this matter two schools of thought sharply differentiated. On the one hand we have chemists so impressed with the necessity of avoiding discrepancies that they are anxious to set up standard methods stated in such detail that a faithful observance of the prescriptions by two workers cannot fail to secure identical results. And there are others less confident of the success of this system.

This conflict of opinion arises in great measure from confusion of thought. There are many operations performed by the chemist which are from their nature arbitrary. To take an extreme case it is evidently impossible to carry out the Maumené test for oils or to determine the flashing point of petroleum and to obtain concordant results without having recourse to a fixed procedure. In the examination of potable waters such arbitrary methods are in wide and general employment and yield much useful information.

But this sort of codification, though useful and often necessary, has nothing to do with analysis. The object of the analyst is to determine with the best precision in his power the constituents of the substance which he is analyzing. Sometimes he cannot do this and is forced to have recourse to the determination of the properties of the substance; that is to say, he is compelled to apply to the material under examination various arbitrary tests—standardization for these tests is legitimate enough. Standardization of analysis implies that analysis is an arbitrary procedure not based on ultimate chemical facts; this view is too grotesque for discussion.

To turn to the much-debated question of discrepancies in analytical results which is at the root of the whole matter. In trade it is necessary frequently to appeal to the analyst, and if the results given by one analyst differ from those of another examining what is believed to be the same sample much delay and expense may be incurred. The trader is usually unaware of the great difficulty which exists in procuring identical samples and he is almost certainly ignorant of the slow and laborious character of all analytical processes having claim to be exact. From the former cause he is disposed to ascribe all differences to errors of the analyst, and from the latter he is inclined to urge greater rapidity of work than is compatible with accuracy. Sometimes from bad sampling or from hurried or unskilful work discordant or erroneous results may arise. Then the trader seeks the remedy and believes that it may be found in a standard method of analysis. It need hardly be urged before this assembly that such a conclusion is fallacious. The same imperfection in sampling, the same hurried and unskilful work will lead to the same erroneous results; the only difference will be that each chemikant, for he cannot be called a chemiker, will be entitled to say that he has followed the prescription as faithfully as he was able.

It is not likely that chemists who practice as independent consultants will submit to dictation even from a committee of their peers as to the methods they are to employ. A member of this branch of the profession asked to determine in some material a definite constituent is either competent to choose a suitable method and to execute it accurately or he is not. If he is, a standard method is superfluous; if he is not, his early retirement is desirable and will probably occur from the operation of natural causes. But there are some consultants who are more or less identified with particular branches of the chemical trade—they are constantly called upon to carry out analyses or assays for the buyers and sellers of ores, metals, minerals, salts, and the like, and usually the results obtained by the buyer's and the seller's chemist are compared and may be found to disagree. Now here is a plausible case for the use of a standard method. It is argued that if the two chemists concerned were to use the same process the likelihood of their disagreement would be diminished. There is even a limited truth in this; the likelihood of disagreement would be diminished to some extent because both operators would be exposed to identical chances of error instead of different chances. But the object of analysis is not to obtain a false concord by repeating a process, errors and all, with Chinese fidelity; it is to arrive at the truth as closely as knowledge and skill will allow and one of the recognized methods of doing this is to vary the conditions of experiment.

The need of the buyer's and seller's chemist for identical results will best be met by ensuring that they are sufficiently well trained to refuse to employ a faulty method; their choice among several sound methods is obviously a matter of indifference. It is only when the assay is from its nature arbitrary and is in fact a conventional test that an identity of method is necessary.

A great part of the clamor for standardization arises from the discrepancies which often occur between the results of different works chemists, and it appears that the "standard" methods which have from time to time been proposed in the United States have the works chemist as their particular objective. These discrepancies occur and are highly inconvenient, not only immediately to those concerned, but ultimately as tending to discredit the value of analytical control of manufacturing processes. When last in America I took some pains to ascertain the opinion of chemists on this point and found that those who advocated the adoption of standard methods when confronted with the grave objections which can be urged against them, took refuge in the necessities of the works chemist, maintaining that only by the provision for him of standard methods could uniformity and accuracy be attained.

It cannot be denied that this view is defensible, but it is defensible on one ground alone and that hardly likely to commend itself to the works chemist. His friends, in their anxiety to help him, infer that he is incompetent and needs to be guarded and guided like a school boy. Now, as a matter of fact, although often overburdened with work and most inadequately paid, the works chemist has done much to advance analytical chemistry, originating some methods and improving many others. It is neither just nor courteous to assert that he above all others is in need of direction and supervision from without, and that he is willing to barter his right of individual judgment according to his training and experience for a bundle of prescriptions.

It is, however, unfortunately true that while there is nothing in the nature of things why the works chemist should not be as highly trained and as capable of individual decision as his consulting colleague, yet it remains a fact that some works chemists are not fully competent, and conscious of their deficiency might even welcome the promulgation of a standard method by which a given analytical process shall be carried out. Such cases are freely advanced by the advocates for standardization and doubtless afford some show of argument in favor of the movement. But surely it is better and sounder to direct effort not towards the provision of rules for half-trained chemists, but towards ensuring that the chemists are fully trained.

Here one is met by the money question. At present the average manufacturer is so little alive to the absolute necessity of obtaining proper scientific and technical aid in the conduct of his business that he will offer to the chemist a salary hardly in excess of the wages of a skilled mechanic. Is it to be wondered at that the man who is willing to accept such remuneration should not be fully trained, that his knowledge should be empirical and that he should need the prop of a "standard" method scientifically on a par with a cookery recipe? If it is the desire of those who advocate the standardization of chemical methods to promote the multiplication of analytical machines turning out results of artificial uniformity, no better course could be adopted than the prescription in detail of processes which shall relieve their user from the troublesome process of thinking. I do not like to suppose that this is the object deliberately desired, but it is well at least to recognize that it is likely to be attained by the successful establishment of standard analytical methods.

There are other results to be expected of wider and more general importance. Let us suppose that standard methods had been prepared and published with the consent and under the direction of some body of chemists of sufficient standing to make their pronouncements authoritative. The position of all chemists who ventured to disagree with the findings of this central body would become very difficult. In all cases of dispute in all legal proceedings these dissentients would be placed at a disadvantage; on them would be thrown the onus of proving, usually before a non-technical tribunal, that the method they preferred was as good as that of the central committee. Now it is as certain as anything not actually accomplished can be, that the standard method at its best would be a compromise between the different processes in use by the various specialists in that particular branch of work and would have the usual quality of a compromise, namely, the preference of expediency for principle. Consequently, no independent worker basing his process on what he conceived to be the soundest principles could avoid a conflict with a method which from its origin is a hybrid product. If the dissentient were not able to convince the lay tribunal that his process was reliable, a grave injustice might be done to him; if on the other hand he did so succeed, the standard process would be discredited. A whole vista of trouble and dispute can be foreseen. The endeavor here made to trace to its logical outcome the effect of standardization is sufficient to show that such a scheme even if it could be regarded as desirable would lead to such complications as to render it impracticable.

But there are still further drawbacks of a kind yet more serious. If a standard process is adopted by a central authority it will be regarded by many as final and all incentive to original inquiry in that direction will be removed. Periodical revising by a standing committee will probably be carried out, but naturally on the lines of the existing process and with the view of improving it in detail. The deviser of a method radically different from that which is official will be regarded as a sort of chemical heretic and will receive the treatment usually accorded to the heterodox.

To turn to the construction of a positive policy. The spirit which is dissatisfied with the present status of the analyst, that does not hesitate to indicate the causes of errors and discrepancies and is eager to incur serious and voluntary labor in order to diminish the frequency of their occurrence, is so entirely admirable that if it [illegible] towards a better end than the construction of a [illegible] and ineffective code, it could not fail to animate [illegible] and more liberal project with its own zeal. The[illegible] many branches of analysis (as distinct from arb[illegible] methods of chemical examination) in which there exists some doubt whether certain of the recognized [illegible]ods are actually as reliable as the users of them [illegible]tain. It would be outside the scope of this paper [illegible] forward a list of these discussable methods; every [illegible]ticing chemist can provide illustrations from his [illegible] work and the specialists in any well-defined bran[illegible] analytical work would, if they agreed in nothing else, [illegible] thoroughly in accord with the idea that revision of [illegible] accepted processes after proper experimental inquiry [illegible] be usefully undertaken. To realize this idea it seem[illegible]me that there might be formed, preferably under the [illegible]pices of the British Association, standing committee[illegible] chemists interested in particular branches of analyti[illegible] work; that those committees should meet as often as [illegible] practicable in order that their members might confer; [illegible] each should draw up a program of work to be carried out by selected members of the committee, the program to be directed to the examination of existing methods of analysis, to the elimination of sources of error which might be discovered and to the devising of new and improved processes; that the results of the deliberations of these committees should be published periodically in order that chemists at large might be informed of the progress made and warned against the errors discovered. All these inquiries would be of vast value to professional chemists who would be in a position to judge how far the methods indicated might usefully be received and adopted.

It will be seen that the program suggested differs radically from that to which I have ventured to take exception. The latter involves the pronouncement of a defined method for the determination of a given substance; the former is directed to the discovery of latent errors and to the provision of processes free from these. In the one case a set of rules is imposed from without, in the other advance and improvement will take place from within unfettered by canon and unhampered by rule. I think it not too much to say that the whole spirit of science, which is instinct with the love of freedom and the defiance of mere authority, will be found favorable to the plan which I have put forward and will unconditionally condemn any attempt to standardize methods of chemical analysis.

A METHOD OF PREPARING AND PRESERVING RECORDS OF RAILWAY REAL ESTATE.

By Arthur Haviland, M. Am. Soc. C. E.*

DESCRIPTION AND CONTENTS OF RECORD SHEETS.—A sun-print, in blue and white, or black and white, mounted or otherwise, 20 ins. × 30 ins., is the unit of filing of maps of the property of a railway, and when arranged consecutively in groups representing the line in each county, placed in light covers, and filed in proper cases, these units are in the most convenient, economical and useful form. Copies may be issued to any person or office requiring them, and these, when colored, are a perfected record of the positions and dimensions of each parcel of the property of the company, of the source of title, and of the rights pertinent thereto.

The tracings from which these prints are made, drawn in black to a scale of 100 ft. per in, show tracks, buildings, mile posts, crossings, bridges, signals, fences, monuments, and boundary lines of properties, municipalities, and taxing districts. They show also the chained stations of boundary lines, stations, buildings, bridges, and, by numbers, the deeds or other written instruments conveying title. They may be made from notes taken on surveys for this purpose, when all the data will be obtained, or from old maps (on scale of 1-1200 preferred), to which will then be added information obtained by methods noted below. They are filed in a secure place in groups by counties and form the authoritative record of the railway company's property, and being posted to date are exact, complete and easily handled.

The fact that the maps are made in black requires a scheme of lines to avoid flatness in the drawing and to insure intelligibility. An unbroken line is used for the rails and the outlines of structures; all others, by arrangements of dots and dashes, represent fences, land lines, municipal boundaries and traverse lines. The dimensions, material and use of buildings are indicated by figures and letters. (See Fig. 1.) The sheets have reference marks so that any two may be so joined that a continuous tracing may be made.

*Grand Central Station, New York, N. Y.

Upon the sheets, showing the roadway and adjoining lands of the railway company, the various parcels of land are numbered consecutively, beginning the series at a terminus or county line. Each parcel, the title of which is acquired by a conveyance, or instrument, is given a number. If several parcels not adjoining are conveyed by

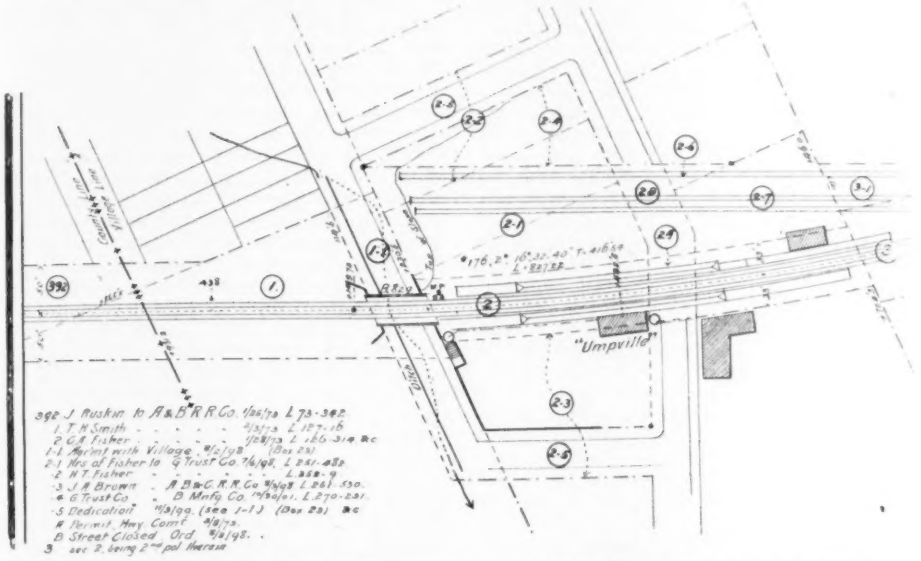

"Umpville"
392 J. Ruskin to A.B.&C.R.R.Co. 1/26/70 L 73-382
1 T. H. Smith
2 C.A. Fisher
1-1 Agmt with Village 8/2/98 (Box 23)
2-1 Mrs. of Fisher to G. Trust Co. 7/6/98 L 241-482
2 M.T. Fisher
3 J.A. Brown - A.B.&C.R.R.Co 9/4/98 L 261-550.
4 G. Trust Co - B. Mfg Co. 1st/6/01. L 270-251.
5 Dedication 11/3/99. (see 1-1) (Box 23) Bc
A Permit, Hwy. Comr 4/9/73.
B Street Closed Ord 8/2/98.
3 see 2, being 2nd pcl therein

FIG. 1. EXAMPLE OF MAP SHEETS FORMING RECORDS OF RAILWAY REAL ESTATE.

an instrument, they are given separate numbers. If several "parcels" in a deed describe a body of land, they jointly are designated by a number. Parcels acquired subsequently will be numbered to correspond with the land first purchased having the same source of title. If, for instance, a farm, through which the road was first built and designated by the number 119, is subdivided, and any parts bought by the company, these parcels on the tracings will be designated by the same number as the farm with an additional figure to indicate its divided title, as 119-3. So, also, will be indicated by similar subordinate numbers or letters the existence of any law, ordinance, grant or agreement (other than deed) affecting the use of a parcel of land, or of a road, stream, bridge, etc.

The deeds and all papers referring to title are designated by the parcel number and arranged numerically in the files. By this plan, all the title papers pertaining to any section are grouped, and one may be assured that all the information concerning the rights of the company is in hand without the perplexity and uncertainty of searching for papers filed in various places.

On each sheet is given in tabular form the numbering of the parcels, and the subordinate numbers, the names of grantor and of grantee—railroad company or trustee—with the date and place of record of the deed, and such reference to the grants, ordinance, etc., affecting the use as may be thought proper. Cessions by the railroad company will be indicated by same means.

The records in the office of the Register or Clerk of the County are examined and copies of all papers not in the files obtained. These lists of recorded papers are preserved in proper books, and to the entry of each deed is added its map number.

If this series of sheets had been traced from the old rolled maps of the railroad and completed as above, the work (costing about $5 per mile of railway) would result in a convenient form of maps, with a compilation of all known information, and a critical examination of the company's title and covenants affecting its rights.

The instruments conveying title are filed in suitable boxes, and the "Abstracts," with papers affecting title (numbered the same as the parcel to which they refer), are filed in another place. The maps from which the tracings were made, or information obtained, are stored. Besides the deeds, there are many papers relating to the rights of use of the lands, which are filed, noted and often referred to, such as grants by national, state or municipal authority, agreements with railway companies, municipalities and individuals, charters of cities and villages, and leases from and to the company. Notes on defects of title, purchase-money mortgages and other liens should be carefully kept. The filing of all these is readily controlled by a card index, with a "guide card" having the name of the station, town or county, having behind it a series of "tab-cards," each referring to one of the subjects above.

METHOD OF COMPILING RECORD SHEETS.—The sheets traced from the old maps will probably give the alinement, position of property lines, and dimensions of lands acquired by the railway company. To make these complete, additional information is necessary, which may be obtained most economically by a chaining party of two men and an instrument party of three.

Beginning at a zero to be fixed at a terminus, the chaining proceeds along the gage side of the right-hand rail of that track which becomes the left-hand or in-bound track of the main line of the railway. Stations of 100 ft. are marked on the base of the rail in red chalk. At each ten stations, a stroke of white paint is made and a 2-in. × 2-in. oak stake (or 1¼-in. iron pipe), painted white with the number of the 1,000 ft. station in black, is set at right angles to the station mark on rail and outside of the roadbed. Notes are made of the stations and pluses (to the nearest 1-10 ft.) of cross-fences, municipal boundaries, mile posts, buildings, bridges, roads, frog-points and the approximate ends of curves and their degree, also occasionally the distance from the rail to the railway fence. From these notes are made schedules of the positions of stations, bridges, road and other crossings, mile posts, curves and the boundaries of taxing districts.

The degree of curvature may be determined, close enough for identification, by counting the rails in the arc subtending a versed sine formed visually by the gage, when fifteen 30-ft. rails will indicate 1° curve, eleven 2°, nine 3°, eight 4°, seven 5°, six 6°, etc.

An instrument party of three men finds the stations of the ends of curves on the center line of original location, taking as a radius that shown by the maps, with tangents, parallel to the track, in such position as may be determined from compilation (more or less extensive) of all facts affecting it. The ends of curves are then fixed by stone monuments set on the original center line and the location of each is referred to the stationing on the adjoining rail. A convenient check on the accuracy of the survey, and the avoidance of magnetic variation in all descriptions for deeds, might be found by reference to astronomical meridians.

After the monuments at the P. C.'s are set, the center line is remeasured by a 200-ft. compensating balance chain. It is evident that if the track were straight or returned to the same bearing as the initial tangent, the difference of chainings along rail and along center line would probably be the error in the rail measurements. The difference in the length of the two lines measured is found by multiplying the offset of the two lines by the tangent of the difference of bearing of the initial tangent and that of the tangent at place of comparison. Applying this correction to the difference of chainings, will give the error along the rail. Owing to several changes in alinement of tracks no test of the accuracy of the rail chaining is as yet possible, but, along a line with rather unusual changes, the probable error was found to be about ⅓ ft. per mile. However, the chaining along the rail furnishes stations for resurveys and detail maps—is more accurate than the average survey of adjoining lands—is sufficient for all practical purposes of construction and operation, and perhaps renders unnecessary the more exact and expensive measuring with a compensated chain.

We then have, on the ground, fixed points from which all surveys for improvements will be made, and in the office, notes from which corrected maps may be made, and the papers relating to title examined and filed.

METHOD OF FILING RECORDS.—The section, Fig. 2, shows the 30 shelves in a double-door closet above a series of long shallow drawers with locks, and below a series of unlocked drawers, above which are bins with drop doors and movable partitions.

This case is made of steel, lacquered, with brass trimmings. Access to the upper part is by means of a ladder with broad platform on top, supported by wheels on the floor, and guided by rollers engaging with a rail above the closet. A hand rail below the bin doors adds to the security of its use. On the inside of the closet doors is a small scale map of the territory to which the portfolios refer, showing the lines of railway, position and

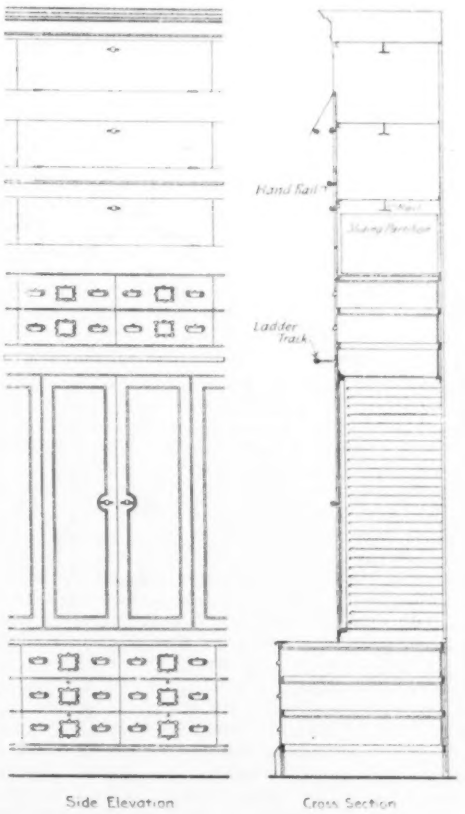


Fig. 2. Section and Elevation of Filing Case for Railway Real Estate Records.

name of stations and town boundaries and names, and along the railways are noted the numbers of the volumes containing the maps thereof. The locked drawers are intended for the filing of the tracings from which the prints are made. The unlocked drawers are used for the filing of papers (other than deeds) relating to title. The bins are

occupied by maps of no present use, but to which reference may at some time be desirable.

A case for the filing of copies of maps filed in the office of county clerks, to which some deeds may refer, and for the filing of maps showing "studies" of title, explanatory of difficult abstracts, should be provided. Also, cases for the filing of printed atlases, and of wall maps, will be found convenient, if not necessary.

The deeds are filed in steel document boxes in which they, in a vertical position, are pressed by a planquette of hard wood held in place by a locking-bar. As the rims of these boxes fit neatly into grooves, the contents are free from dust and assured of safety from the smoke of any fire less than destructive. The boxes are as nearly filled with papers as convenience and the probability of additions may dictate. The label on the boxes states the name of the railway or branch line, county, town, and the numbers of the deeds contained, and a reference to the number of the map or atlas of the railway.

The boxes are arranged geographically in a steel frame, in which they may be secured by means of a small handle operating a locking device engaging 60 boxes. This frame is above a series of small drawers used for the filing of abstracts and "other papers" (muniments of title), giving all possible information as to title and the history of its acquisition. Drawers for this purpose should be of such dimensions as to afford ready access to any papers, and at same time to economize space. Papers of this character should be filed on edge in numbered packages placed in rows across the drawer, and the depth of the drawer should be about ½-in. greater than the width of the folded papers, of a length sufficient to allow two or three rows of papers and of a width not much over 19 ins., but determined by the dimensions of the space allotted or 4 ins. deep by 19 ins. wide by 19 or 28 ins. long. If this method of proportioning is not used, the drawer will necessitate the piling of papers, and much delay and vexation in handling them will be the result.

The rights of a railway company to the use of parts of its property depend upon legislation by the national, state or municipal authorities, sometimes contained in books in the law library or in the "ordinances" of cities and villages, and sometimes more definitely expressed by written agreements or permits. All these are a part of the records of railway real estate and, as far as possible, should be on file and reference thereto made on the maps. The rights of municipal authority require the filing, also, of the charters of cities and villages. These papers may be conveniently filed in the upper drawers. The opening and closing of streets, the laying out of roads along or across the railroad, and all matters relating to the history, rights in and use of highways is highly important, and require careful attention and complete filing and notation. The papers will consist of maps, copies of proceedings, consents, ordinances and deeds of dedication.

It is suggested that to avoid the handling and mutilation of the original deeds, often made on brittle paper, and already showing symptoms of approaching destruction, that a skeleton copy of each should be made on a suitable card, to be filed with the Engineer's department for use in the making of maps or land diagrams. These copies, besides names, date, and place of record, need only contain copy of any covenant affecting use or reversion and a sketch showing lands conveyed, or a shortened form of the description.

A "working case," containing closets for filing of books containing indices, records and other books and document boxes for filing of papers of general reference and in constant use, is also necessary. The boxes are used for the collection of memoranda on important subjects, of such character that they cannot be placed in a locality file until completed and compiled, or of information relating to general affairs, or filing of lists of deeds, maps, papers, etc.

In this case a series of drawers, 3 × 5 ins., in section, for the filing of about 12,000 index cards, containing information concerning railway properties, rights and use, not contained in the deeds.

Upon a guide card is printed the name of that portion of the line of railroad, information concerning which is contained on the cards behind it. These names are those of stations, municipal districts, streams, roads or streets, sidings, curves, cuts, tunnels or other places designated by colloquial (often slang) terms, which might occur in conversation or correspondence of a local superintendent or foreman. The cards are arranged alphabetically. Behind them are placed tab cards, each designed to receive memoranda or information of different kinds. In preparing such or any card index, no hope should be entertained that the first scheme of arrangement is the final one, because the accumulation of information will develop advisable changes to accommodate the whole when subdivided into the many classes of interests affecting railway real estate. As the tab cards are cut and numbered to twelve only, the series may be extended by coloring with red pencil the tabs of those intended for numbers from 13 to 24, with blue pencil the tabs of those from 25 to 36, etc. In this series notes are made upon the subjects of history, legislation, use and filing, and a tab card is devoted to each of these subjects: history of place, filings of deeds and maps, history of constructions, water supply, sidings used by others, gravel pits, wharves, permits by municipalities, streets crossed and history of, street railways and railroad crossings and junctions, farm and other crossings, defects in title, lands for sale to or by company, and others as occasion requires.

The maps of the railroad properties show conveyances to companies now extinct, whose franchises have been ceded by sale or lost through foreclosure, or to companies still existing whose line of road is operated under a lease. The title of the present company to the lands so acquired, its rights and duties thereto, depend upon transfers anl litigations so complex that a clear, concise and accurate record should be maintained. The material for this record is dispersed and its collection is one of considerable labor, leading through the books of "minutes" of the older companies, the recorded conveyances and filed maps, county clerk's minutes and files, histories of the localities and the memories of the oldest officials. The attempt to compile *at once* such history in a completed form, unless the matter has been prepared in the interest of each company, would probably be a failure. The method of collecting information and the readiest form of preservation is suggested by card index system. A proper receptacle contains a series of colored guide cards upon each of which is inscribed the name of a railway company appearing upon the maps as a grantee. These arranged alphabetically form the skeleton upon which may be built the fabric of the "corporation history," as the material therefor may come to hand. Behind each of these cards are arranged tab cards upon which are noted respectively the date and other facts of incorporation, the proposed termini and route, counties and towns, mortgages, leases to and by, foreclosures, reorganization, trustees of title and present officers. The names of railway companies appearing on the maps as "grantors" of fee or easement might be included in this history by the use of white guide cards, and, if necessary, the history of each before and after the date of the grant could be kept.

ANNUAL CONVENTION OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES & BUILDINGS.

The annual convention of this Association was held at Minneapolis, Minn., October 21 to 23, the headquarters and place of meeting being at the West Hotel. The convention was called to order about 10.30 a. m., Oct. 21, the proceedings being opened with prayer by the Chaplain, Mr. J. H. Cummin (L. I. R. R.). An address of welcome by the Mayor, Mr. D. P. Jones, was responded to by Mr. Cummin, and an address was also made by Mr. W. G. Nye on behalf of the convention committee of the Commercial Club. The President, Mr. W. S. Danes (Wabash R. R.) then read a brief address, in which he referred to the fact that the increase in weight of modern locomotives and rolling stock has made it necessary to increase the capacity of bridges. The reports of the Secretary, Treasurer, Executive Committee and the Committee on Memoirs were then read. The reports of technical committees followed, after which came the discussion of last year's reports, and then the discussion of the reports of the present meeting. For the sake of convenience we shall give the reports and discussions together.

DISCUSSIONS OF REPORTS OF 1901.

STATION PLATFORMS.—Mr. Pickering (Bos. & Me. R. R.) is using granite chips from a quarry where paving stone is made. The coarser material is used for the bottom and covered with the fine chips, the stone being then rolled with a heavy roller. This proves very satisfactory. The C. M. & St. P. Ry. is also making platforms with stone screenings. Mr. Sattley (C. & N. W. Ry.) has abandoned the use of broken stone, as it tracked into the cars. He uses a wooden curb, 8 ins. above the rail, filled in with gravel and paved with brick. The cost is from 10½ to 12½ cts. per sq. ft., everything included, according to the price of brick. Some speakers considered brick the best and concrete next.

WATER STATIONS.—One member spoke of using iron trestles instead of the usual timber towers to support the water tanks. Tanks of corrugated iron and of concrete reinforced with expanded metal were referred to, but no definite information was given concerning them.

BRIDGE RENEWALS.—Several speakers considered it best and most economical for the railway company itself to do this work. If done by contract it should be under the company's supervision. Mr. Reid (L. S. & M. S. Ry.) stated that no work of this kind is done by contract on lines under traffic. In one case a contracting firm bid $14.75 per ton for removing an iron bridge, the railway company to built the falsework. The company did the work itself for $9.75 per ton, including the falsework.

BRIDGE GANGS.—Mr. Reid (L. S. & M. S. Ry.) has eight bridge outfits, each including a dining car and sleeping car, so that the men can be cared for while at work and can sleep while going to emergency work. By thus providing for the men's comfort he is able to get and keep better men than would otherwise be the case.

AUXILIARY COALING STATIONS.

This was the first committee report presented, and an abstract is given in another column. The conclusions were that the cars should be hauled or pushed up an incline into an elevated coal station and the coal dumped directly into the pockets; or if the incline is impracticable, then a ground storage line with elevator to fill the upper bins is recommended. Where it is necessary to coal engines on several tracks a conveyor system should be used.

The discussion on this report occupied nearly the whole of the evening session. Mr. C. A. Lichty (C. & N. W. Ry.) said that the new plant at Fond du Lac has elevated lines to which the coal cars are hauled up a steep incline by a gasoline engine. The coal is broken to a uniform size at the mines, as otherwise there is trouble in dumping the cars. He advocated some means of weighing or measuring the coal, so as to have a check on the enginemen and firemen. Mr. A. S. Markley (C. & E. I. Ry.) thought provision should be made for unloading gondolas or box cars, as railways cannot always get drop-bottom cars. As to weighing, he thought this did not mean much. If an engine with 3 tons in the tender takes 5 tons before starting out, it is credited with 5 tons instead of 8 tons. Mr. W. A. McGonagle (D. & I. R. Ry.) thought that the weighing of coal at coaling stations was simply a waste of money. The dynamometer system of recording weights, as used at many stations, requires continual repair and attention, and on his road this attachment has been cut out of service as being very expensive and of little benefit. The weighing of coal at coaling stations when delivering to the engines is largely guesswork. It should be weighed at the dock and then charged out to the engines at so much per mile run. He thought it would be better to stop weighing coal and keeping coal accounts with the individual enginemen, and instead to spend more money in employing competent traveling enginemen.

Mr. A. Montzheimer (C. & N. W. Ry.) and other

members, however, considered that very good results came from weighing the coal as delivered to the engines. The cost of keeping the accounts on each division is not great, and there is a rivalry among the men as to their coal records. It was pointed out, however, that various factors, including the quality of coal at different stations, affect the comparisons of coal records. Mr. Cummin (L. I. R. R.) said that the Pennsylvania R. R. at Jersey City delivered coal to engines on the main track, the train stopping for the purpose. The amount of coal is weighed and the engineman and fireman sign a coal ticket. The engines are rated with an allowance of so much coal for 100 miles, and the records are made up monthly from these tickets. The Long Island R. R. has erected a large coaling station at Newtown Creek, Long Island City, where 90% of the engines take coal. Drop-bottom cars on two tracks deliver coal into a storage bin of 3,000 tons capacity, from which a link-belt conveyor supplies a delivery bin of 1,800 tons. For unloading coal from canal boats into the storage bin there is a traveling crane with clam-shell bucket. Five tracks run transversely through the shore end of the building, so that five engines can take coal at once. The cost of handling coal from the dock to the delivery bin is 2⅞ cts. per ton from cars and 3 cts. per ton from canal boats.

MAIL CRANES.

This report consisted simply of half a dozen brief replies to a circular of enquiry. It was supplemented by a number of illustrations, all of which, however, showed modifications of the ordinary mail crane with two horizontal arms between which the mail bag is carried. The discussion developed nothing very new; some of the members preferred iron mail cranes and others spoke of the desirability of introducing an improved method of delivering mail bags from the cars. A combined mail bag catcher and receiver invented by Mr. G. R. Moore, of Erie, Pa., was briefly described. Mr. Reid stated that on the L. S. & M. S. Ry. mail bags are taken by trains running at 90 miles an hour without any difficulty.

ROOF COVERINGS FOR RAILWAY BUILDINGS.

Slate is much used for station buildings where there is not much climbing for the repair of skylights or telegraph wires. It has a life of 35 to 40 years, and the roof should have a pitch of not less than 6 ins. per ft. Vitrified tile is very durable when rightly made and laid on steep roofs, but is not adapted for ordinary railway buildings. Shingle roofs last 28 years, and should be laid with 6-in. pitch, they are very satisfactory where slate is too expensive. For flat roofs, a tar and gravel composition is preferred, and will last 12 to 18 or even 30 years. Slag or broken stone of the size of peas is sometimes used instead of gravel. In such roofs, much depends upon the paper used, the pitch, and the thoroughness of the work. Three-ply is too light, 4-ply is good, but 5-ply is better. Asphalt paper and asphalt pitch are sometimes preferred to coal tar, but the latter is sufficiently durable. An asphalt-gravel roof must slope not more than ½-in. per ft., on account of the liability to run in hot weather; but tar gravel roofs may have a pitch of 1 in. per ft. With such very flat roofs as are required for asphalt, any settlement will form hollows to hold water.

Sheet metal roofs, corrugated or flat, are not durable. Steel is less durable than iron, and will last only about one year, where exposed to engine gases. Tinned shingles of good quality give good results. Painted shingles have a short life unless frequently painted.

Of patented roof coverings, Sparham is pulverized talcose lime rock, mixed with coal tar pitch and applied hot to the roof with a trowel. This may be used for a flat roof or for a pitch of 3 or 4 ins. per ft. Ruberoid is a wool-felt saturated with a paraffine preparation. Perfected granite roofing is 2-ply tarred paper with sea-grit on one side. Both of these last may be used for any pitch not flatter than 2 ins. per ft. Cheap roofs made with roofing papers require periodical mopping with tar, and if thus treated every two years (before the paper or felt is bare) will last almost indefinitely. In railway work, however, roofs are generally left without attention until leaks are reported, when it is too late for a mopping of tar to do any good.

Roofs requiring treatment every two years can hardly be regarded as permanent. Slate for pitched roofs and tar and gravel for flat roofs are as nearly permanent as can be obtained for railway buildings. The cost per square for roofing of different kinds in New England is as follows:

Slate	$9.00 to $12.00	Tar & gravel.	$4.00 to $5.00
Tile	30.00 " 33.00	Sparham	5.00 " 5.50
Shingles:		Ruberoid	2.75 " 3.75
Sawed cedar	4.50 " 5.00	Prfctd granite	2.75 " 3.25
Tinned	5.00 " 6.50	Paroid	3.00 " 3.50
Sheet tin with standg seam	6.50 " 8.00	2-ply, double.	2.00 " 2.25
		3-ply, single.	1.50 " 2.00

The discussion consisted mainly of individual expressions of experience with different kinds of roofing, and showed very great differences of opinion and experience.

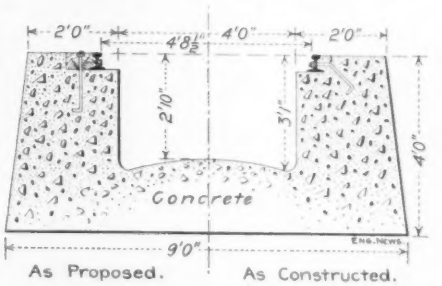
TRACK PILE DRIVERS.

This report was comparatively brief, but was supplemented by numerous statements from individual members. We publish a separate abstract of this report and the supplementary matter on another page. It appeared that these machines drive piles 15 to 20 ft. ahead of the car and from 9 to 22½ ft. on either side. The leaders are 35 to 47 ft. long, or sufficient to take a 35-ft. pile under the hammer. One road uses leaders 18 to 24 ft. long, suspended from the boom of a derrick car. The weight of hammer varies from 2,000 to 3,600 lbs., and one member recommended two hammers, of 2,200 and 3,600 lbs., for different kinds of work. The pile driver engines are usually of 20 to 30 HP.

The discussion was very brief. Mr. B. F. Pickering (Boston & Maine R. R.) preferred to use a locomotive attached to the pile driver instead of a self-propelling machine, and also advocated having all movements made by steam power, as in bad weather it sometimes takes 6 or 8 men to swing the pile driver. If the machine is to be self-propelling, a separate engine should be provided, instead of relying on the one engine. Mr. Sattley (C. & N. W. Ry.) and others preferred the self-propelling machines.

ROUNDHOUSE PITS.

The report recommended a pit with convex bottom, so that men working in it would not be standing in drainage water. The Chicago & Eastern Illinois Ry. uses a pit 4 ft. wide, 2 ft. 10 ins. deep at middle and sides. It is of monolithic concrete, 4 ft. deep, 8 ft. over all on top and 9 ft. over the bottom. The top of each wall is formed with a bevel to receive a rail, with its top level with the top of the wall. The rail is secured to anchor bolts projecting through the concrete and passing through the web of the rail, but another design provides for a wooden stringer on the inside of the rail, secured by nuts on vertical anchor bolts This is shown in the accompanying cut.



Cross-Section of Roundhouse Pit; Chicago and Eastern Illinois R. R.

BRIDGE FLOORS.

An abstract of this report is given in another column. Practically the only discussion was the description by Mr. Reid (L. S. & M. S. Ry.) of a double floor with tarred paper between the two layers of planking.

COST OF OPERATING TURNTABLES.

An abstract of this report is also given in another column. It consisted of separate individual statements, and the rather lengthy discussion clearly established the fact that no comparison could be made betweeen the figures as they were not based on any uniform method of accounting. One member thought it poor practice to install an old light steam engine for this work, while another thought it uneconomical to purchase an entirely new and expensive electric plant except where a great number of engines have to be turned. One member spoke of turning 400 engines per day on an electric table. Mr. Pickering thought at many points where only a few engines have to be turned the work can most economically be done by the men employed in cleaning the cinder pits, etc. In one case, on his line, double-end engines are used in suburban service to obviate the necessity of frequent turning. A resolution was passed to the effect that the writers of the report should get together and arrive at some uniform basis for their figures before the report is printed in the proceedings.

OFFICERS.

The election of officers resulted as follows: President, B. F. Pickering, Boston & Maine R. R., Sanbornville, N. H. Vice-Presidents, C. C. Mallard, Southern Pacific Ry.; A. Shane, Tol., St. L. & Western Ry.; A. Zimmerman, Colorado & Southern Ry.; and Arthur Montzheimer, C. & N. W. Ry. Treasurer, N. W. Thompson, P., Ft. W. & C. Ry. Secretary, F. S. Patterson, Boston & Maine R. R., Concord, N. H. The next meeting will be held at Quebec in 1903.

ENTERTAINMENTS.

These included a trolley ride to Minnehaha Falls, a theatre party, and a carriage ride to the Pillsbury flour mills and the new government dam, the return drive being through the parks and residence district of Minneapolis. On Oct. 21 the party went to St. Paul on special electric cars, which took them through the interesting parts of that city, after which a visit was paid to the works of the American Hoist & Derrick Co., and that company gave a dinner at the Commercial Club. The party returned to Minneapolis in time to take train for Duluth and a two days' trip through the iron mining region of northern Minnesota.

METER SYSTEM OF THE WATER DEPARTMENT OF BALTIMORE, MD.

By Robert L. Clemmitt.*

There are in service in the city of Baltimore about 1,800 water meters, of all sizes and kinds. This small number of metered services in so large a city is accounted for by the fact that until quite recently the use of meters was practically optional with the consumer; therefore meters, especially of the smaller sizes, were used only where the consumer was benefited. A recent regulation of the water board requires that all services over 1 in. shall be metered, which will in time result in a large increase in the number of meters.

The meters now in service cover all classes of property, but generally the consumers are those using water in large quantities, such as manufacturing plants, railroad watering stations, hotels and elevator supplies.

The testing, inspection, quarterly reading and general management of the system, except collecting the bills, falls to the lot of the writer, and this article is intended to show the methods used.

All meters used in this department are bought by contract, proposals being advertised for about the first of each year, and they must be furnished according to a rigid specification.

A well-equipped meter-testing room is maintained at the department's machine shop, where all new meters are carefully tested for accuracy of registration, loss of pressure, etc., when received from the manufacturer. All old ones, after being repaired in the shop, are turned over to the testing room for final adjustment and "tuning up." None are allowed to be placed in service showing an error of more than 2%. Fig. 1 shows a section of the testing room and apparatus.

On taking charge of this branch of the work, the system of records, accounting and inspection was found to be obsolete, so that an entirely new system had to be devised. The city was divided into four meter districts, numbered one, two, three and four, and each meter was inspected and given a service number; the initial figure of the service number indicates the district in which the meter is located. Each district is divided into a number of routes, containing not more than 150 locations, so arranged that the inspectors in making their rounds never "double" or go over the same ground twice.

Loose leaf route-books, Fig. 2, are used, each meter having its own page, so that alterations may be made in the routes to suit the growth of the service.

The records in the office are kept entirely on a card system. Fig. 3 shows the index cards, which are filed in drawers behind properly tabbed alphabetical guide cards. The accounts showing the quarterly readings, amount of bill, etc., are kept on ledger cards, Fig. 4, which are filed numerically

*Assistant Engineer, Water Department, Baltimore, Md.

according to service number. The cards of each district are filed in separate drawers.

In the testing room a card system is used to keep a historical record of each meter used in the service, Fig. 5. When a shipment of meters is received each one is tested, and a card filled out for it, which is filed in a drawer according to kind, size and the manufacturer's number. On the reverse of this card all repairs are entered, and this shows a comparison of the cost of repairs to the amount of water registered.

The card system used seems to be especially adapted to records and accounts of this kind, as reference to any meter is almost instantaneous, no dead or obsolete matter is carried, and it allows for an enormous increase in the system without any inconvenience or over-lapping, as in a book system.

Since the adoption of this system the time required to take quarterly readings has been reduced one-half, the meters have been kept in better repair, and the whole system generally is in better condition than formerly.

The meters used here are installed by the department, at the expense of the consumers, the latter paying the cost of all labor and material, except in some special cases where the department deems it advisable to install the meter for its own protection, and all repairs are paid for by the consumers.

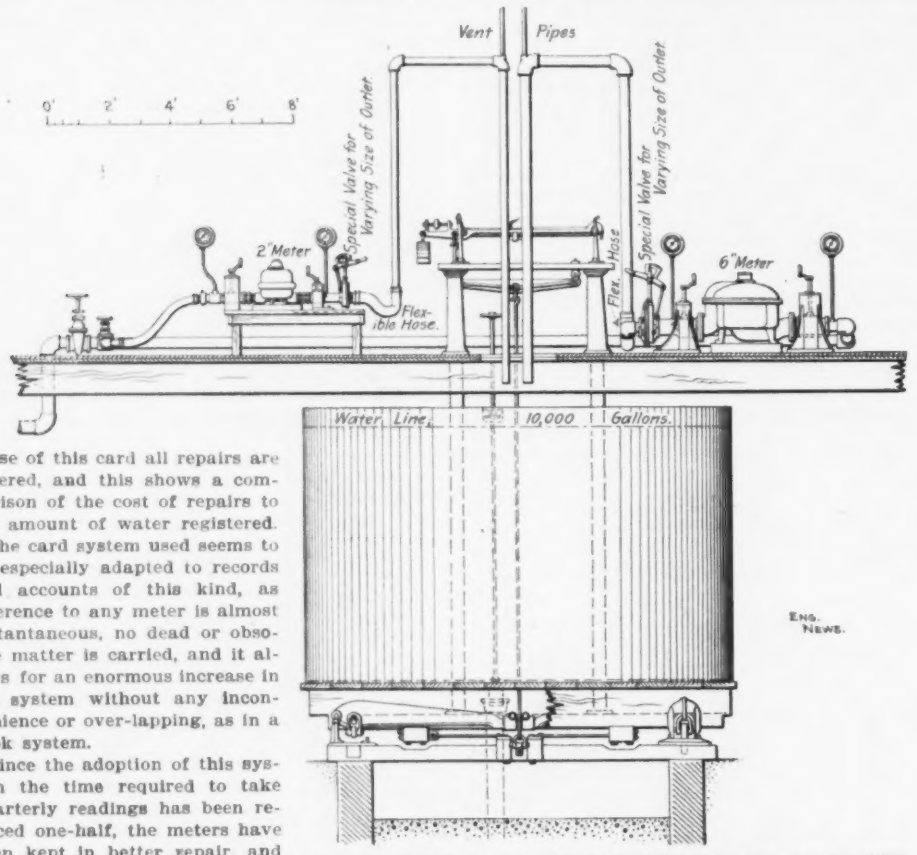


FIG. 1. SECTION OF METER-TESTING ROOM, BALTIMORE WATER DEPARTMENT.

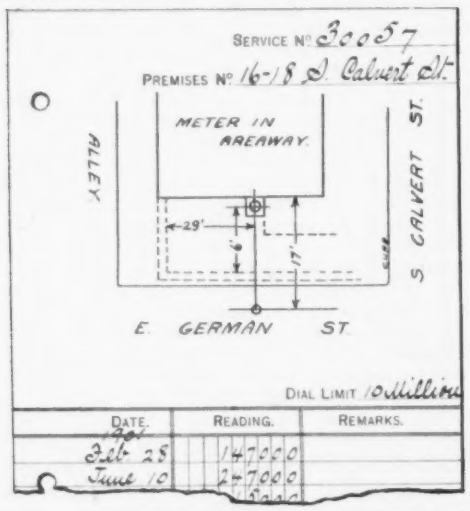


Fig. 2. Upper Half of Page of Meter Inspector's Route-Book, Baltimore, Md.

(The full page is 4¾ ins. wide and 10 ins. high, with spaces for 22 readings on the side shown and 38 on the reverse, or 60 in all. The left-hand edges have three perforations, for binding.)

During 1901 an experiment was tried to determine the advisability of the department making repairs to meters free of charge to consumers, with the following results: 70 old meters, which had been in service a number of years without repairs, were taken out and repaired; 3 were found to register correctly, 9 over-registered from 1 to 15%, 13 failed to register at all, and 45 under-registered from 1 to 50%.

The earnings of these 70 meters for the year 1900 was $11,864. With all of them in proper working order, and assuming that the same amount of water will be passed through them in the future as in the past, there will be an increase of $1,507 in the annual revenue.

The cost of repairs was $921, showing a clear gain in one year of $586. The experiment is considered quite successful, and the work of repairs is progressing as rapidly as our shop facilities will permit.

The meter specifications for the year 1902 are as follows:

WATER METER SPECIFICATIONS, BALTIMORE, MD.

GENERAL CONDITIONS.—The Contractor under these specifications, and the contract following these specifications, shall furnish Water Meters of such sizes and in such quantities as shall be ordered by the Water Board during the year 1902. All orders shall be filled promptly and delivered, all charges paid at the Department's Shops, corner Oliver and Wolfe Sts., in the City of Baltimore.

METHOD OF BIDDING.—Bidders shall fill out the bids on the blanks furnished for the purpose, in writing and in figures, and in addition to his bid for furnishing the meters, the bidder shall also submit a schedule of prices for duplicates of all parts of all sizes and all kinds of meters he proposes to furnish. Said schedules shall constitute a part of his bid and shall be binding during the term of the contract. The prices bid on all meters shall include all connections usually furnished with the meters.

INSPECTION.—The Water Engineer shall have the right to visit the works of the Contractor, either personally or by representative, and inspect the work in progress for this Department.

SIZE AND TYPE OF METERS.—Proposals will be considered for meters in three classes: (1) On all sizes from ⅝-in. to 6 ins., inclusive of the Rotary or Oscillating Piston displacement type of meters. (2) On 3, 4 and 6-in. of the Inferential or Velocity type of meters. (3) On ⅝, ¾, and 1-in. of the Disk type of meters.

MATERIALS AND WORKMANSHIP.—All meters furnished shall be of the best and latest approved design and so constructed that the working parts can be readily exposed for inspection and repair. All 3, 4 and 6-in. Inferential or Velocity meters shall have fish traps of large capacity attached and fitted with suitable arrangements for blowing out and cleaning without disturbing the other parts of the meter.

All meters of sizes from ⅝ to 2 ins. inclusive shall have bottom castings of cast iron or bronze, and the bonnets of bronze, and the pistons or disks shall be protected by an inside cylinder or case of bronze or hard rubber; or if no inside casing is used, the bottom case shall be of bronze.

All the cast-iron parts shall be of a superior quality of cast iron, free from all impurities or defects, such as blow holes, lumps, blisters, etc., true to pattern and finished in a neat and workmanlike manner.

All bronze parts shall be of a superior quality of composition suitable for the purposes used. All pistons, propellers, and disks shall be of the best hard rubber.

The 3, 4 and 6-in. meters may have tops and bottoms of cast iron, with propellers working in bronze cylinders or between bronze-faced surfaces.

All meters shall be well painted outside, and all cast-iron parts on the inside, with best metallic paint, or shall be galvanized.

Contractors must submit with their bid a drawing showing a longitudinal section of one of each type of meter they propose to furnish under these specifications, on which shall be drawn and plainly indicated by name all the parts of the meter and the material of which each part is to be made, to show that the meter to be furnished will conform to what the specifications call for in these particulars.

Bidders submitting bids on meters which have not heretofore been tested by this Department, must furnish with their bids a sample of each size and kind of meter bid on, so that the Department can test them.

REGISTERS.—All meters shall be fitted with first-class straight or round dial registers as required, having plain black figures on white enamel, and be protected by sealed caps to keep out vermin, dirt or water.

CAPACITIES.—All meters shall have not less than the following capacities in cubic feet per minute when running full bore under pressure of 60 lbs. per sq. in. at the inlet: ⅝-in., 2 cu. ft.; ¾-in., 4 cu. ft.; 1-in., 8 cu. ft.; 1½-in., 12 cu. ft.; 2-in., 20 cu. ft.; 3-in., 70 cu. ft.; 4-in., 120 cu. ft.; 6-in., 275 cu. ft.

TESTING.—One meter from each lot ordered will be selected for testing, and the whole lot may be rejected or accepted on the results of the test of this one meter, or if in the judgment of the Water Engineer, it is deemed necessary, each meter may be tested separately and accepted or rejected on its own merits. Any defects developed in transit, or any parts broken or injured in the operations of testing shall be made good or replaced by the Contractor at his own expense?

Any meter showing slight defects or imperfections may be repaired or calibrated in the Department's Machine Shop, and the cost of such work will be charged against the Contractor and deducted from any money due or which may become due him.

Meters will be tested first for accuracy of registration under a pressure of 50 lbs. per sq. in. at the inlet, and will be required to register as follows:

All ⅝, ¾ and 1-in. on all sizes of opening at outlet from full bore down to ⅛, shall not under-register more than 0.5%.

All 1½ and 2-in. on all sizes of opening at outlet from full bore down to ¼, shall not under-register more than 1%.

All 3, 4 and 6-in. on all sizes of opening at outlet from full bore down to ½-in., shall not under-register more than 2%.

No meter will be accepted which registers a greater amount than actually passed.

Tests for loss of pressure will be made by putting the meters under a pressure of 50 lbs. per sq. in. with an opening at the outlet equal to one-half the bore of the meter, and will be required to show a loss of pressure not greater than the following: ⅝, ¾ and 1-in., 30%; 2-in., 40%; 3, 4 and 6-in. will be tested for loss of pressure under actual conditions of service, by being placed in the elevator supply pipe at the Department's Shop. The elevator will be operated, loaded with a weight of 1,500 lbs., and the pressure at the inlet and outlet carefully noted.

All 3-in. meters will be required to show not more than

Premises No.	16 & 18 S. Calvert St	Ser. No.	30057
Owned by	Guardian Trust and Deposit Co.		
Agent	A.C. Merryman, Secty		
Occupied By	The Owners and Tenants		
Property used for	Office Building		
Meter Covers	Entire Premises		
Installed	Aug. 23 1900	Cost of Meter	$175.00
Size and Kind	4" Disc	Cost of Installation	54.79
Mfg. No.	263892	Total Cost	229.79
Limit of Dial	10 Million		

Fig. 3. Meter Index Card, Baltimore Water Department.

(The full size of this card is 5 × 3 ins. The reverse is ruled for "Remarks.")

22% loss of pressure; all 4-in. not more than 12%; all 6-in. not more than 1% of pressure, under these conditions.

Durability tests will be made by allowing water to pass freely through the meters at full bore under pressure of 50 lbs. at the inlet until the following quantities have been registered by the size named: ⅝-in., 50,000 cu. ft.; ¾-in., 75,000; 1-in., 150,000; 1½-in., 250,000; 2-in., 350,000 cu. ft.

7

PREMISES No. 16 & 18 S. Calvert St. SERVICE No. 30057

LIMIT OF DIAL 10 Million

DATE OF READING	METER READING	CONSUMPTION CU. FT.	RATE	AM'T. OF BILL	REMARKS
1901 Feby 28	1470000	890000	45	40 05	141
June 10	2470000	1000000		45 00	
[illegible]	[illegible]	[illegible]		75 60	

FIG. 4. UPPER ONE-FOURTH OF METER LEDGER CARDS, BALTIMORE WATER DEPARTMENT.

(The full size of this card is 8 × 5 ins., and the column headings and ledger rulings, but not the other matter, is repeated on the reverse side.)

After these quantities have been registered the meters will be tested again for accuracy of registration, and shall not show a loss of more than 1% from the first test.

The special valve used in the meter-testing room to regulate the flow of water is shown in detail in Fig. 6, and in position by Fig. 1. The outlet part of the valve is a square equal in area to a 4-in. pipe, and by lowering the sliding gate any desired area may be secured. The scale placed on the operating lever is graduated for openings equal to circles from ⅛-in. to full bore.

The use of this valve will obviate the use of disks placed on the outlet side of the testing machine, which is now the common practice, and will enable a test to be made in much less time and with greater convenience to the operator.

THE NEW WORKS OF THE B. F. STURTEVANT CO., AT HYDE PARK, MASSACHUSETTS.

By W. B. Snow,* M. Am. Soc. M. E.

The new works of the B. F. Sturtevant Co., now nearing completion at Hyde Park, Mass., present an excellent opportunity to study the factiors that control in the location and design of the modern manufacturing plant. The present plant at Jamaica Plain, Mass., is limited in its opportunity for growth, its capacity has long been strained to the utmost, and, as a consequence, the question of removal has continued to present itself with ever-increasing force.

Aside from the general character of the lot itself the principal factors considered in reaching a decision were proximity to raw materials, and to an abundance of skilled labor, adequate shipping facilities, ample water supply, and space for ready disposal of waste material. The advantages of the West as against the East were carefully weighed, but the company readily expressed its abiding faith in the prosperity of New England, in the facilities which it presents for work of the character conducted by this company, and in the quality of its skilled labor as an offset to the present somewhat higher cost of raw material.

The best combination of advantages was presented by a lot of nearly 20 acres of land in the town of Hyde Park, Mass., having a frontage of about 1,300 ft. upon the freight yard of the N. Y., N. H. & H. R. R. at Readville station. One side of the lot is bounded by a plentiful stream known as Mother Brook and the adjacent shore is at a level of nearly 10 feet below that of the yard and buildings, thus providing sufficient space for dumping waste material for years to come.

The site having been selected, most careful consideration was given to the size and character of the buildings; the head of each department was consulted, his recommendations reduced to writing, and frequent conferences held as to the requirements of the individual departments. With these data at hand the individual and aggregate areas were determined and the plans started with the idea of providing a total floor space slightly more than double that of the present plant.

Consideration was then given to the question of the number of floors to be provided in the various buildings. The lay of the land and its available area being somewhat against a group of one-story buildings, and a simple calculation showing that the actual cost of the power expended in a single year for lifting the entire product of the works through a distance of 20 feet figured only a little over a dollar, determined the company upon the building of multi-storied buildings. The character of the products of this company readily lent itself to such a design, and it was believed that the fixed charges on elevating machinery would be more than offset by a reduction in the horizontal distances necessary to be traversed.

The arrangement of the buildings was determined by the provision to be made for growth. One arrangement of a series of parallel buildings permitted increase only by multiplication of buildings, but provided an excellent opportunity for the carrying of switch tracks across both ends of each building. The other arrangement provided for a group of buildings parallel to the railroad tracks with accommodation for switch tracks between buildings, and for their entrance at the ends of the building, with an opportunity for growth by extension in length. After a careful comparison the latter arrangement was adopted.

The construction of the buildings next received consideration. The latest development of all-steel and concrete construction with large window areas did not appear to meet the requirements of a group of buildings as permanent and substantial in their character as these. All-steel buildings, brick walls and concrete fireproof floors presented disadvantages in the way of discomfort to workmen, inconvenience in attaching machines on hangers, and excessive expense, which did not appear to be offset by advantages to be secured in the way of absolutely fireproof construction.

The type finally selected is composite in its character, consisting of steel interior columns and main steel girders, with heavy brick walls, wood timbered floor and plank roofs. In the case of the one-story foundry, the roof is supported by steel trusses; in the other buildings open timbering with wooden columns in the upper floor is employed. The main floor in the machine shop is of tar concrete with spruce and maple flooring. The uper floors are carried upon wooden beams spanning the spaces between the steel girders, which follow a unit system of 20 feet on centers through the building. All roofs are of 3-in. plank with tar and gravel top.

The question of power was early decided to the extent that the entire plant would be electrically driven from a central power house; that the engines would run condensing, that the exhaust steam derived from engines under test, which is considerable, would be utilized for heating, with supplementary amount of live steam admitted at reduced pressure as might be required. The final decision regarding the power house placed it sufficiently far from the ends of the buildings to permit sufficient extension of each and near enough

Size and Style 3/4" Ensign gax. Made by National Meter Co. Mfg. No. 271681

Style of Register Straight Reading Limit One million Purchased Nov. 16 - 1900

Cost $15.75 Tested Nov. 21 st 1900 By Phillips

RESULT OF TEST WHEN NEW.

Inlet	Duration of Test	Readings Start	Readings Stop	Flow Reg.	Flow Act.	Flow per Min. Reg.	Flow per Min. Act.	Registered to Actual Flow	Pressure Inlet	Pressure Outlet	Pressure Loss
Ins.	Min.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	%	Lbs.	Lbs.	%
1/8	9	000	2	2	2	0.22	0.22	100	50	50	00
1/4	5	2	7	5	5	1.	1.	100	50	45	10
3/4	4	7	22	15	15	3.75	3.75	100	50	5	90

Installed Nov 22 1900 At 314 N. Holliday St Ser. No 20096

For W. W. Towson & Co.

Remarks

Face.

REPAIRS

Date	Cost	Test Recd.	When Sent Out	Nature of Repairs	Cu. Ft. to date
1901 12-17	3 62	Hung up	100	New finish & facing off (Frozen)	10000

Reverse Side.

FIG. 5. TESTING ROOM METER RECORD CARD, BALTIMORE WATER DEPARTMENT.

(The illustration shows the upper three-fourths of the face and the upper one-fourth of the reverse side of the card. The full size of the card is 6 × 4 ins., and the lower part of the card is perforated for inserting a locking-rod.)

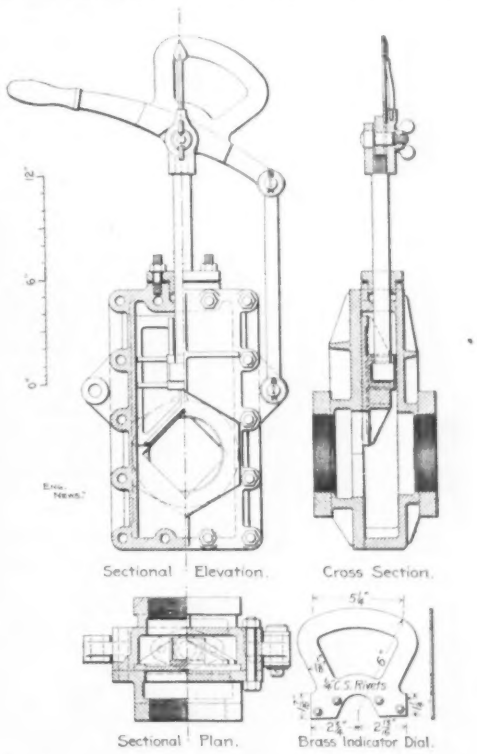


Fig. 6. Details of Valve for Varying Size of Outlet in Meter Testing Apparatus, Baltimore, Md.

*Mechanical Engineer, B. F. Sturtevant Co., Jamaica Plain, Mass.

to the water supply to reduce to a minimum the expense of conveying condensing and other water.

The pattern building has at one end a two-story portion accommodating carpenters and flask makers on the first floor, and pattern makers upon the second floor. The balance of the building is devoted to pattern storage, and is provided with intermediate floors, making four in all. It is separated from the other portion of the building by double fire walls and automatic fire-closing doors.

The foundry, 170×350 ft. in dimensions, is designed with the idea of distributing iron upon a track system, and is to be equipped with narrow-gage railways bedded in concrete, making runways between the molding floors. Two craneways run lengthwise of the building through the greater part of its length, and the tracks extend beneath the crosswise traveling cranes in the cleaning room at the end of the building.

From the foundry the castings will pass to the rear of either the machine shop or the fan shop. The former is of the familiar gallery type, 500 ft. long, with wings 40 ft. wide, and a central runway of the same width for a crane of 20-ton capacity. The lighting will be principally by a series of saw-toothed skylights running crosswise of the roof with glass facing due north. The crane will serve the entire floor and transport heavy castings from the machine tools to the erecting floor, where the completed engine or generator may be lifted upon a transfer car passing through the testing building and there picked up by another 20-ton crane, which will drop it upon the testing plate and subsequently carry it forward to the steam railway track which passes through the end of the building. The upper floor of this building, together with portions of the adjoining buildings, is devoted to the electrical department and provided with individual small traveling cranes.

The building devoted to the manufacture of fans, heaters, etc., is 80 feet in width and three stories in height, and of the same length as the machine shop. It is of typical mill construction, provided with all conveniences for handling material.

The smith shop, 40×80 feet, serves both buildings with equal facility, while the wash house and locker room, 40×100 ft. and three stories in height, is so located as to reduce to a minimum the distance to be traversed by the individual workman. The third floor will be used as a lunch room.

The standard first floor height in the main building is 17 feet; that of the second and third stories is 15 feet.

The office is to serve as headquarters for the entire business. It will contain the correspondence, designing and drafting offices, the superintendent's quarters and the cost department, the advertising bureau and a printing office, which will be located in the basement. It will be three stories in height, with a finished attic to provide additional drafting room space.

ABSTRACTS OF REPORTS AT THE CONVENTION OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

AUXILIARY COALING STATIONS.

The several systems of delivering coal to empties at auxiliary coaling stations may be enumerated as follows:

1. Shoveling from Cars to Tender.—This is usually employed where work trains or pushers are in service. It is expensive and should not be used except where there is only a very small consumption of fuel. The cost of operating this system, as usually employed, will approximate 25 cts. per ton.

2. Shoveling from Cars to High Platform and Thence to Tender.—This system is frequently employed at points where two or three car loads of coal per day are used. Like No. 1, it is a makeshift and should not be used except where conditions of poverty compel its use. The cost of operating this system varies from 25 to 50 cts. per ton, depending upon conditions of labor and climate.

3. Crane and Bucket from Storage Platform.—This system is in use on numerous roads. The coal is dumped from cars from an elevated trestle to a storage platform on the ground. It is then shoveled into buckets and pushed on tram cars to the crane, where it is hoisted and dumped into the engine tender. The system is antiquated and very expensive, and several reports show as high a cost as 35 cts. per ton, the cost depending on labor conditions and the distance the coal is trammed.

4. Shoveling from Cars into Bins from Elevated Trestle.—This is known as the Williams-White system. Numerous variations have been made in order to avoid the royalty asked by the inventors, but the results generally show that it would have been better to pay the royalty. The cost of coaling by this system varies from 6 to 10 cts. per ton, depending upon labor conditions. The system is generally satisfactory where a moderate amount of fuel is required and topographical conditions will permit the necessary inclined trestle to be constructed economically.

5. Dumping Coal from Railway Cars Directly into Bins.—This is the ideal system of coaling locomotives. The coal is taken in bottom or side dump cars and dumped by trainmen directly into bins, thus eliminating all the extra labor required by the other systems and saving very largely the delay of cars. Its use is limited by topographical conditions in constructing the inclined trestle approach. The cost of coaling by this system varies from 1½ to 3 cts. per ton.

6. Hauling Cars up Incline by Cable and Dumping Directly Into Bins—This system is ideal, where the previous system will not apply, on account of topographical conditions. The objection to it is the fixed charge for labor and supplies for hoisting engine and the expensive maintenance of cables and pulleys, but notwithstanding these charges the stations are operated at the very low cost of 3 cts. per ton.

7. Dumping Coal from Cars into Pit and Elevating it by Conveyors.—This is very satisfactory when it can be operated in connection with a pumping station, in order to divide the cost of operation. There is considerable expense and frequent annoying delays with conveyors of any type, but notwithstanding this, the cost of operation has been reported as low as 3 cts. per ton. One great advantage of this system is that it can be constructed in localities where No. 5 and No. 6 are out of the question, on account of the ground occupied by the inclined trestle approach. This system is very compact and is admirably adapted for all points where yard room is limited and where there is suitable drainage for the dumping pit.

8. Dumping Coal from Cars into Pit and Elevating it by Air Hoist.—This is in use in several places where a limited amount of coal is required to help engines over the road. The coal is dumped into a pit under the main track and thence by gravity into buckets. These buckets are hoisted by an air hoist operated by the compressed air from the train line of the locomotive taking coal. The cost is 5 to 10 cts. per ton, but the system cannot be recommended except as stated above.

9. Locomotive Crane Working from Stock Pile to Bin or to Locomotives.—This system is in use on at least two important lines, and seems to give entire satisfaction. It is particularly to be recommended where large storage is required. The coal is stored by being dumped from a high trestle to a platform on the ground. A locomotive crane is then run on the same high trestle and the coal is picked up with a clam shell and dumped into movable pockets for engine use or into gondola cars for immediate shipment. The movable chutes are a novel feature and are moved from place to place along the coal pile as the coal is removed by the locomotive crane. The cost of coaling by this system is 1¾ cts. per ton.

10. Dumping Through Trestle to Platform and Tramming and Dumping into Tenders.—This system is in use in several places where large storage is required. It is expensive, as are all systems where the coal has to be shoveled. It is not to be compared with No. 9 in economy of operation, but of course is much cheaper in construction. The cost of coaling by this system is from 10 to 15 cts. per ton.

11. Dumping into Pit in Track and Elevating Bucket by Switch Rope from Engine Taking Coal.—This is in use on several roads, but is not very satisfactory, owing to the danger of personal injury by broken ropes and sheaves. The cost appears to be low, but the real cost when accidents are considered is prohibitive. The apparent cost of coaling by this system is from 5 to 10 cts. per ton.

Two methods somewhat different from those described above are in common use on eastern roads. They are applicable where the number of engines to be coaled per day does not warrant the installation of expensive plants, and where there is ample time to take coal without delaying train movements.

One may be described as a dump-car method and the other as a tub method. Both are usually supplied by an inclined trestle running to any height desirable, from 12 to 25 ft., and with the storage covered or open, as may be decided upon.

In the former a great deal of the coal is discharged from the overhead trestle through a rough hopper spout directly into the dump cars below. When no supply is available for loading the cars in this way, they are filled by shoveling from the store pile.

The tub method involves the use of a derrick, operated by any power. The power generally, however, on the Boston & Maine R. R., is the locomotive itself. The fall is led through a sheave in the step block of the derrick and along the side of shed to a snatch block at a sufficient distance, so that when the line is made fast to the side of a tender, the engine in moving opposite the derrick will have raised a tub to the proper height for swinging over the tender, where it can be dumped. Tubs of one ton and ½-ton are used, the former being raised by a running block in the bight of the fall, and the latter by a single line. The tubs are of wood, running on wheels. The cost of derrick, rigging and 10 tubs is $700. Cost of operation 10 to 12 cts. per ton.

Your committee, after due consideration of all the information sent, have drawn the following conclusions:

1. The best type of auxiliary station is that by which the coal for locomotive supply is dumped from bottom or side dump railroad cars directly into the bins, the cars being pushed up an inclined trestle by a locomotive, dumped by the trainmen, and the empty car taken away immediately thereafter. This is designated as No. 5 in our report, and the cost of coaling locomotives can be reduced to 1½ cts. per ton, and all fixed charges for operation avoided.

2. Where topographical conditions prevent the construction of the long inclined approach, we recommend the system of hauling the railway car by gasoline engine hoist up a trestle approach of 20% grade and dumping the coal directly into the bins. This is designated as No. 6 in our report, and the cost of coaling locomotives is 3 cts. per ton.

3. Where topographical conditions further prevent the construction of the steep incline, or where the crowded yard conditions prevent the adoption of the previous systems, we recommend the type of pockets known as the McHenry system, where the coal is dumped from cars into a pit under the track and elevated to bins by a conveyor system. This is designated in our report as No. 7, and can be operated at a cost of 3 cts. per ton.

4. Where it is necessary to coal engines from several tracks we recommend the conveyor system in use by the New York Central & Hudson River R. R. The experience of this very important railroad has demonstrated the success of this type of coaling station. The cost of operating by this system is 3 to 6 cts. per ton, depending upon the amount of coal used.

5. Where large storage capacity is required, we recommend the system employed by the Southern Pacific Ry. and the Louisville & Nashville Ry., where the coal is dumped from a high trestle into bins for immediate use, or to a platform for storage, and is picked up from storage by a locomotive crane with clam-shell dipper and dumped into bins or directly into locomotive tenders, as desired. The movable chutes are especially commended as ingenious and effective. The cost of coaling by this system is 1¾ cts. per ton.

6. Where it is necessary to shovel coal once, or where coal must be received in gondola or box cars, your committee recommend the Williams-White chutes as being the best under the given conditions. The cost of coaling by this system varies from 6 to 10 cts. per ton. This is designated as No. 4 in our report.

W. A. McGonagle, G. W. Smith, E. Fisher, J. P. Snow, B. F. Bond, R. B. Tweedy.

Table of Auxiliary Coaling Stations.

Railway.	Type of station.	Cost of construction.	Tons capacity of pockets.	Cost of coaling per ton, cts.
Seaboard Air Line	10	$4,500	825	9
N. & W.	5	6,000	...	2½ to 3½
Tex. Midland	5	3,760	10	21
C., M. & St. P.	4	100 per pocket 1,600 per trestle	4½	7
C. R. R. of N. J.	..	....	...	5.9
Phila. & Reading	5	22,900	35	5
Great Northern	6	6,500	6	3
A., T. & S. Fe	6	8,000	5	3 to 7
D. & I. R. R. R.	7	4,000	50	3
D., S. S. & A.	3	....	...	15
P. & L. E.	7	15,000	200	..
L. & N.	9	38,000	3, 4, 5 and 7	3 per bu.
B., C. R. & N.	4	2,550	...	10
So. Pac. Co.	9	9,000	8	1¾
N. Y. C. & H. R. R.	8	5,500	...	10
N. Y. C. & H. R. R.	5	....	...	5
N. Y. C. & H. R. R.	7	9,000	160	3 to 6
N. Y. C. & H. R. R.	7	15,000	450	3 to 6
N. Y. C. & H. R. R.	7	9,500	160	3 to 6
N. Y. C. & H. R. R.	7	19,000	300	3 to 6
N. Y. C. & H. R. R.	7	22,000	850	3 to 6
N. Y. C. & H. R. R.	7	24,300	850	3 to 6
N. Y. C. & H. R. R.	7	18,000	420	3 to 6
St. L. & S. F.	4	....	...	7.38
Wabash	4	7,170	...	6.1
D. M. & N.	5	3,500	...	1¼ to 3
Penna. R. R.	5	6,200	230	2½ to 3
Penna. R. R.	5	6,600	253	2½ to 3
Mex. Cent. R. R.	4	4,200	5	6¼
C., R. I. & P.	4	1,600	6	6 to 7½
M. & St. L.	4	150 per pocket	...	7½ to 8½
C. & E. I. R. R.	4	4,400	...	5½ to 6½
Pere Marquette	7	7,600	2 at 40 tons	..
Pere Marquette	7	3,600	4 at 40 tons	..
M. C. R. R.	7	18,000	3 to 7 tons	3½ to 5

TURNTABLES OPERATED BY POWER.

The 65-ft. turntable at Huntington, Ind., on the Erie Ry., is now operated by steam at a total cost of $141. Of this $102 is for labor and $39 for material. The engine is an old 14-HP. vertical engine, which had been considered as obsolete and of no value for the past 12 years. The table can be operated successfully with 20 lbs. of steam, but they generally use 30 lbs. There is no trouble whatever in the handling of our heaviest engines which weigh about 316,400 lbs.

The steam is taken from the stationary boilers in the roundhouses and so far there has been very little if any in-

crease in the amount of fuel used under these boilers. Before this power was installed the cost of operating the table was $180 per month; of course some of this would be chargeable to cleaning up around the table and radial tracks. Since the installation of this power the expense has been reduced to $90 per month; one man during the day and one man at night. W. O. Eggleston, Erie Ry.

(The engine is mounted on the turntable, at one end, and by a link-belt drives a train of gearing which drives a 28-in. wheel running on the turntable track.—Ed.)

In my report to the association last October I stated that the Lehigh Valley R. R. had one gasoline engine in service operating a 64-ft. turntable at Coxton, Pa. Since that date this company has installed four additional gasoline engines and one electric motor for operating turntables. The gasoline engines are by Fairbanks, Morse & Co., 5 HP. The electric motor is 20 HP., manufactured by the General Electric Co. The total cost of installing a gasoline engine apparatus is about $1,100. The total cost of installing electric motor apparatus is about $1,150. The economy of operating the turntables by power depends on the number of engines required to be handled at a certain point as the following records of expenses for various turntables will show. The average figures of cost do not include the interest on first cost of plants, nor any depreciation of the plant. These items will amount to about 45 cts. per day. F. E. Schall, L. V. Ry.

	Turntables on Lehigh Valley Ry.					
	Coxton.	Lehighton.	So. Easton.	Wilkesbarre.	E. Buffalo.	Sayre.
Diameter	64 ft.	75 ft.	75 ft.	75 ft.	75 ft.	64 ft..
Motive power	5-HP. gasol.	5-HP. gasol.	5-HP. gaso.	5-HP. gaso.	5-HP. gasol.	20-HP. elec.
Installed	July, 1901.	Feb. 1902.	March, 1902.	March, 1902.	April, 1902.	June, 1902.
Engs. turned per 24 hours	174	121	188	46	103	109
Cost per engine	2.21 cts.	2.9 cts.	1.97 cts.	6.5 cts.	3.37 cts.	3.7 cts.
Cost of labor operated per 24 hours	$3.78	$3 41	$3.74	$2.91	$3.41	$4.10

WEARING SURFACE OF ROADWAY FOR OVERHEAD BRIDGES.

The report of this committee showed that hard pine and oak plank are commonly used for flooring. The cost is $20 to $25, and the life from 6 to 10 years, or even 15 to 20 years (this latter being on the Chicago & Northwestern). There is usually no protection from the exhaust of engines or damage from fire. Mr. Sheldon (N. Y., N. H. & H. R. R.) uses the following:

A, 3-in. plank costing 15 cts. per sq. ft., life 6 years, 12 lbs. per sq. ft.; B, Trinidad asphalt, 20 cts., 6 to 15 years, 50 lbs.; C, Granite blocks, 28 cts., 20 years, 100 lbs.

We have found that with a traffic that will wear out 3-in. plank in two years, Trinidad asphalt will last from six to seven years. Our experience has been that where a large volume of business is done, requiring a strong bridge with a wearing surface of asphalt, concrete, or granite blocks, it will last enough longer to more than pay for the extra cost of a bridge strong enough to carry the added weight and the expense of an under floor to support the concrete or paving.

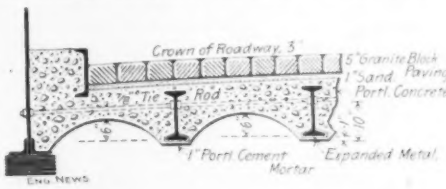
(Arthur Montzheimer, Chicago & North Western R. R.)—On our ordinary country bridges we use 3-in. pine plank, and on some of our city bridges 3-in. oak plank. In Chicago we have two viaducts covered with 7-in. yellow pine blocks 4 × 6 and 4 × 8 ins. The I-beams in the floor are covered with 3-in. pine plank, and the blocks set directly on this floor. The blocks cost $1.42 per sq. yd.; paving pitch to cement the blocks, 4 cts.; labor, 23 cts.; the total cost per yd. being $1.69. I consider this kind of paving as durable as any that can be put down, and traffic is very heavy on these viaducts. The bridges are not protected from exhaust of engines in any way, except over the few tracks where the traffic is very heavy. At this point we build a roof, which is hung over the I-beams on the floor of the bridge. This roof is built out of D. and M. ceiling and slopes so that the sweat from the viaduct will not drop on the engines.

(A. S. Markley, Chicago & Eastern Illinois Ry.)—I use white oak plank 4 ins. thick, laid on 6-in. string pieces 2 ft. apart. The space between these string pieces is filled with cinders or gravel. This costs $10 per M. laid, and will last from six to eight years, depending altogether on the amount of travel. Where traffic is very heavy it will not last to exceed three years, and will always wear out before it decays. I refer in particular to our teamways in Chicago, where a great amount of teaming is done. This does not apply, of course, to overhead wagon bridges, where a floor of this kind will last from 12 to 14 years.

(J. P. Canty, Boston & Maine R. R.)—The accompanying cut shows style of highway bridge floor construction used on the division where I am located, which gives a very substantial foundation and present a long-lasting surface.

City highway bridge over railroad tracks, carrying electric railroad tracks. Paved with granite blocks with Portland cement joints. Cost of floor per sq. ft. of roadway, steel, $1.169; paving and sand, $.233; concrete, $.359; total, $1.761. After two years of service the wearing surface is in apparently as good condition as when first built. The traffic is heavy. The bottom flanges of stringers are covered with expanded metal and Portland cement mortar. Weight of floor per sq. ft. of roadway: Steel, 26.37 lbs.; concrete, 128.09 lbs.; sand, 8.30 lbs.; paving, 66.80 lbs.; total, 230.06 lbs.

Town highway bridges over railroad tracks have Georgia pine stringers and plank; two layers of plank, 2 ins. on bottom and 3 ins. on top. The floor costs 40 cts. per sq. ft. of roadway. Top plank will last about 6 years, bottom plank and stringers about 12 years. Weight of floor per sq. ft. of roadway, 37 lbs.



Floor of Bridge Over Boston & Maine R. R., at Fitchburg, Mass.

Country roadway bridges over railway tracks have Georgia pine stringers and one 3-in. layer of pine plank. The floor costs 30 cts. per sq. ft. of roadway, and weighs 27 lbs. per sq. ft.

W. O. Eggleston, B. F. Pickering, J. B. Sheldon, C. P. Austin, J. M. Staten, O. J. Travis.

A NEW STREET SIGN ORDINANCE for San Francisco has been adopted in accordance with recommendations by the Merchants' Association of that city. It covers signs projecting from buildings, on outside stairways to buildings, on awnings, shades and balconies, and also clocks. Permits are required for clocks, for certain signs projecting from buildings, and for certain signs on descents to buildings, but for all other signs it is only necessary to comply with the ordinance. The latter is being circulated by the association named in the form of a handy little 14-page pamphlet, which, it seems probable, would be of interest to officials and public-spirited citizens in other municipalities. The ordinance is of particular significance because it goes far towards the municipal control of advertising signs.

A MUNICIPAL COLD STORAGE AND ICE PLANT has been built at Wolverhampton, England, at a cost of about $42,000. It forms a part of a larger municipal undertaking, which will include a covered wholesale market close at hand. There are five cold-storage rooms, with a total capacity of 16,650 cu. ft. One room is to be kept at 35° and the others at 22° F. There is also an ice cellar with a capacity of 3,750 cu. ft. The ice plant can turn out ten tons in 24 hours and the cellar will store 90 tons. To save erecting a chimney and boiler plant in the locality, power is supplied from the municipal electric plant. This plan was also considered advantageous because it readily accommodates itself to possible small demands upon the plant. The plant as described by Mr. Geo. Green, borough engineer, in a paper recently printed in the London "Contract Journal," was supplied by the Linde Refrigeration Co., and consists of two compressors, one surface evaporating ammonia condenser; one ice tank, with molds; one filling tank; one thawing-off tank, and an electric overhead traveling crane, motors and an air cooler. The municipality accepts goods from private parties for storage and sells ice on demand.

THE LEAD AND COPPER OUTPUT of the United States for 1901 is discussed by Mr. Charles Kirchoff in the forthcoming Mineral Resources of the United States. Bulletin No. T69 of the U. S. Geological Survey summarizes this report as follows: The total production of refined lead in 1901 was 381,688 short tons; it was 377,679 short tons in 1900. Of this total the net American production was 270,700 short tons. The estimated consumption of lead in the United States in 1901 was 269,905 tons; and the total value of imported lead was $364,459 in 1901, as compared with $702,213 in 1900. The total production of domestic copper in 1901 was 268,782 long tons, as compared with 270,588 long tons in 1900. The total imports of copper into the United States in 1901 amounted to 124,938,323 lbs. The total value of the exports of copper from the United States was $36,071,448 in 1901, as compared with $58,875,439 in 1900. The estimated consumption of copper in the United States was 382,761,014 lbs. in 1901, as against 356,891,121 lbs. in 1900. The world's production of copper was 511,803 long tons in 1901, as against 487,206 tons in 1900. The copper market opened in 1901 rather dull at 17 cts. per lb., and by Jan. 13, 1902, the official price had fallen to 11⅛ cts. for Lake copper.

AN INTERNATIONAL COMMITTEE ON STREET Hygiene was appointed at Paris, in August, 1900, by one of the sections of the International Congress for Hygiene and Demography. The committee consisted of 17 members, with Mr. H. Alfred Roechling, M. Inst. C. E., 18 Market St., Leicester, England, as chairman. Mr. Th. Weyl, M. D., 5 Carmer Strasse, Charlottenburg, Berlin, Germany, as secretary, and Mr. Rudolph Hering, M. Am. Soc. C. E., 170 Broadway, New York city, as the American member. The first meeting of the committee was held at Brussels, Belgium, Sept. 21 to 23, 1902, with five members present. By-laws, a statement of aims and objects, and conclusions to be presented to the Congress at Brussels in 1903 were adopted. The "aims" of the committee include the furtherance of good sanitation as applied to street construction, repair and cleaning; tree planting; provision of public water closets; the storage, removal and final disposal of house, mill, market and slaughter-house refuse. The membership of the committee is not limited, and the committee may add to its numbers. Among the conclusions adopted at the committee meeting were the following: All city scavenging should be done by the municipality, without contractors. Street sweepings should be considered dangerous to health and should preferably be burned. In general, the same statements were made as to house wastes and slaughter-house refuse. Mill and factory refuse, also, ought to be burned.

BECQUEREL RAYS AND RADIO-ACTIVITY formed the theme of a lecture, by Prof. J. J. Thomson, before the British Association at its recent meeting at Belfast, Ireland. The lecture is briefly abstracted in a recent number of the London "Electrician," from which we take the following items: The most important work in investigating radio-activity was done in France, by Prof. and Madame Curie, who discovered and to some extent concentrated the substances giving rise to it. Three such substances have been detected, (1) the well-defined and isolable substance "radium;" (2) a less well-defined and but slightly recognizable substance called "polonium," and (3) a vague and elusive substance called "actinium." Of these three essentially radio-active substances, polonium and actinium have never been obtained in a sufficiently high degree of concentration to make their presence visible in the spectroscope. Only by the evidence of radio-activity can their existence be detected. After Prof. and Mme. Curie had detected radio-activity in pitch blende, it became necessary to concentrate the radio-active constituent, radium, to no less than 5,000 times greater concentration before even the spectroscope would give evidence of its presence. Prof. Thomson also referred to the rate of the emanation from these substances. In the case of pure radium, the radio-activity involves such a slow throwing-off of matter that it would occupy one square centimeter of surface a million years to throw off only one thousandth of one milligram of the substance. The radiation of energy from that same surface is much more marked, however; within the same million years the energy radiated would melt a layer of ice a quarter of a mile thick. It may here be noted that the main discoveries in the field of radio-activity have all been made within the last five years.

WORK AND WAGES ON FRENCH RAILWAYS are briefly discussed by U. S. Consul-General John K. Gowdy, of Paris, in U. S. Consular Reports. He puts the total length of railways and steam and electric tramways in France at about 24,100 miles. According to the latest published returns these lines, in the year, carried 401,793,773 passengers; each traveler averaging 19¼ miles and spending 71 cts. Of this total 5.4% were first-class passengers, and 30.4% second-class. These roads carried in total 120,380,479 tons of goods; with each ton conveyed an average distance of 82 miles, at a rate a little less than 1½ cts. per ton-mile. The total receipts from passengers and freight were $274,503,437; operating expenses were $140,772,035, leaving a net profit of $133,731,402. The average ratio of expenses to profit was 51.3 to 48.7. There were 268,728 employees of all classes, including 26,754 women. It is difficult to give exact wages, as salaries are regulated by the length of service, kind of work and location—even upon the same line. It is stated, however, that as a general figure—the station and track men receive from $18.50 to $28.06 per month; the engine-driver, $36 per month and his "reward" for saving coal, etc., usually amounting to $14 more; firemen on the locomotives, about $25, plus $5.50 extra; a foreman in the shops receives as much as $48.50 per month; an ordinary shop workman, $19.30, and an apprentice, $14 per month. Of 71,273 men working on the principal railways, 56% receive from $16.59 to $26.05 per month, and 84% get from $13.70 to $31.84 per month. These men average 28½ days per month, and from 7 to 12 hours per day. About 15% of the total are also lodged. The large majority of the women are employed as gate-keepers at grade crossings, and they receive very little salary, over one-third of the 15,319 women thus employed receive only about $2.90 per month; half receive from $2.90 to $4.80, and only 601 receive from $7.91 to $10.61 per month. Only five women receive as much as $26 to $32 per month.

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It is easy for any one now to remember the mileage of railways in the United States because it amounts in round numbers to 200,000 miles. "Poor's Manual" for 1902, just ready for issue, gives the total mileage on Dec. 31, 1901, as 198,787 miles, and enough track has certainly been laid since to bring the total up to the 200,000 mark, and probably a little above it.

It may be noted that Poor's figures correspond very closely with those of the Interstate Commerce Commission, published in our issue of Sept. 4 last. These gave the mileage on June 3, 1901, as 197,237 miles. Allowing for the construction in the last half of 1901 would make the figures of the two statisticians coincide very closely.

O the 200,000 miles of railway now in existence, 100,000 miles has been built in the 22 years since 1880. Of this addition of 100,000 miles, however, two-thirds was built in the first eleven years between 1880 and 1891, and the remaining one-third in the eleven years since 1891.

The paper and discussion on steam turbines at the recent Street Railway Association convention (abstracted on another page of this issue) calls attention to the prospect that in one particular field of mechanical engineering work, the steam turbine seems likely to play a very important part. That field is the direct driving of large size electric generators. To equip modern electric power stations furnishing current for either lighting or railway work, very large direct-connected generators are necessary to economy. In the design of such generators the engineer is handicapped by the low speed of the engine (measured in revolutions per minute) and has to make his generator a ponderous machine of large diameter, and consequent great cost to build, transport and erect. With the steam turbine of the Parsons type, however, the speed, in revolutions is just about adapted to the needs of the generator designer, and the size and cost of the generator are greatly reduced.

Now who is to reap the benefit of this saving in the cost of the generator? The turbine builder desires to do so of course, and to this end he furnishes both the turbine and the generator and refuses to sell either separately. The buyer of power house machinery, however, naturally kicks at this policy, and insists that it amounts to "charging what the traffic will bear." His kicking will prove of little avail as long as the manufacture of slow-speed turbines is in the hands of a single concern. Signs are not wanting, however, that other firms will seek a place in the field of turbine manufacture. While there are a large number of patents covering the field, the early patents of Parsons and others are now nearing expiration and a way will very likely be found to get around later detail patents.

As shown in the paper in another column, the steam turbine is a more compact machine than the steam engine, and effects a large saving in first cost of building, foundations and land occupied, while it shows an equal or better economy in the use of steam, when worked in connection with condensers and superheaters. The cost of maintenance also promises to be much less than the steam engine, there being no internal rubbing parts. Taking all these things into consideration, it is evident that builders of electric power stations have good reason to look favorably on turbines for their equipment, and will be greatly interested to see what competition may develop in the construction of these machines.

The standardization of methods of chemical analysis has been carried out in many fields of work by American chemists. In England, however, there is considerable opposition to such standardization. The views of English chemists on this subject are fairly set forth by the well-known chemist, Bertram Blount, in a paper published in this issue. The paper was read at the recent annual meeting of the British Association for the Advancement of Science, and Mr. Blount informs us that the opinions he sets forth have been approved by the Council of the Society of Public Analysts.

It will be noted that Mr. Blount does not oppose all work of standardization in the chemical laboratory, but only those methods and processes in which he conceives standardization to be unnecessary and a bar to progress.

Railway companies which permit cars to run over their roads with automatic couplers out of order subject themselves to risk of heavy damages, on account of employees killed or injured in the use of such cars. An important case has recently been decided by the U. S. Circuit Court for the Northern District of Iowa, in which one of the penalty clauses of the National safety appliance act of 1893 is enforced. This act, it will be remembered, made it unlawful to use any car in interstate commerce "not equipped with couplers coupling automatically by impact, and which can be uncoupled without the necessity of men going between the ends of the cars." A penalty of $100 was fixed for each violation of the act, and in addition it was provided that any employee injured by any such improperly equipped car "should not be deemed to have assumed the risk thereby occasioned."

In September, 1901, a switchman named Emil Voelker was killed in the yards of the Chicago, Milwaukee & St. Paul R. R., at Dubuque, Ia. A cut of cars was kicked down against a standing car, but failed to make the coupling, as the coupling on the standing car was out of order. Voelker went between the cars to fix the defective coupler, and while there a second cut of cars was sent down and pushed the first cut of cars forward, crushing Voelker to death. His widow sued and received a verdict of $9,000 against the railway company, and this has now been affirmed by the court above noted. The decision in the case is printed in "Federal Reporter, Vol. 116, p. 687, and has also been separately reprinted by the Interstate Commerce Commission. A chief feature in the decision is the clause of the statute above noted, which was held to absolve the victim from the charge of contributory negligence.

It is worth noting that the defects of the coupler appear to have been in the unlocking gear. The link connecting the lever and pin was broken, so it was necessary in order to open the knuckle to go between the cars, raise the tumbler with the hand and pull the knuckle open. It was held by the court that such a coupler did not conform to the Safety Appliance law. A peculiar feature of the case was that the applicability of the Safety Appliance law to the case appears to have been wholly overlooked by the lawyers for the plaintiff, and was only brought forward in the charge of the court to the jury.

PRINCIPLES INVOLVED IN THE SETTLEMENT OF THE COAL STRIKE.

Of even more importance than the supply of anthracite coal to relieve the immediate necessities of the public is the fact that the settlement of the strike has been placed in the hands of an impartial commission. It is to be hoped that the investigations of this commission may be broader than the specific points of controversy between the operators and their employees, and may touch upon the broad principles which ought to govern the relations between employer and employee. It is of immediate importance that the strike be settled, but it is of lasting importance that it be settled right.

Two matters have been foremost in the discussions that have gone on during the strike, and it is important that the final report of the Commission should treat of them. They are:

(1) Fair wages to the workman, and (2) individual liberty of the workman.

(1a) Fair wages to a mine laborer underground should equal the average wages paid to the ordinary able-bodied laborer above ground in the same locality, plus a reasonable addition to compensate him for the risk of danger and for the uncomfortable conditions of underground work; also plus a reasonable addition to cover the irregularity of work. (Wages should be higher if a man can get only 200 days' work a year than if he gets 300 days.)

(1b) Fair wages to a skilled miner should include all under (1a), plus a compensation for his skill. The wages may fairly be graded according to the degree of his skill as shown, 1, by the quantity of coal he cuts in a day; 2, by the care he exercises in regard to the quality of coal (freedom from rock and dirt) he delivers, in regard to avoidance of danger to the property and to his fellow workmen, and in regard to avoidance of waste of powder and misuse of tools.

If wages are on a tonnage basis, it is fair that the rate per ton should vary according to the conditions of each mine and room; the more difficult the mining, the higher should be the tonnage rate. In a difficult mine to work, the daily wages earned should be about the same as in an easy mine, because if they were less the miners would not work in a difficult mine; but the royalty to the owner of the mine and the profits to the operator should be less, because the price of coal on cars being the same as at an easy mine, and the labor cost per ton higher, there would be a smaller fraction of the price to be divided between royalty and profit.

(2) Individual liberty of the workman.—The workman should be free to join a union or not as he pleases, and if he has a grievance against the corporation employing him, he should be allowed the right to be represented by officers of his union, if he is a union man, in his appeal for the redress of the grievance. He also should have the right to leave his job after giving proper notice. When he leaves his work, however, any other workman should be free to take his place without fear of intimidation.

The right of any man to apply for and to obtain the place vacated by another is absolute. Any restriction of this right is against public policy and should be opposed if need be by the whole power of the State.

A miner should be allowed to earn as much as

he can without restriction by the rules of a trades-union. Wages naturally tend to find a natural level fixed by the law of supply and demand.. If the operators attempt to reduce wages below this level, they will not be able in the long run to obtain enough men to fill the vacancies caused by death or other accident, or by some of the men leaving to find other employment, or to fill the places made by the opening of new mines or rooms to meet the constantly increasing demand for coal. No combination of operators can for any length of time depress wages below this natural level, for an attempt to do so would only decrease the number of men available to operate the mines. The wages offered must necessarily be high enough to attract men to become miners.

On the other hand, a combination of workmen can force wages above their natural level, but it can only be done by restricting the freedom of other men to seek employment, by intimidation or similar means. Further, high wages mean higher prices for coal to the consumer, and this again means diminished consumption and smaller demand for labor, with a consequent tendency toward a lower rate of wages.

Of course the miners desire a high rate of wages, but the natural way to raise the wage level is by increasing the demand for labor, and the way to do this is to increase the sales of coal, which can only be done by keeping the price low. It is said that the miners have urged the mine operators to raise the price of coal to the public in order that they might be able to pay larger wages. Any such increase in prices, however, will reduce the demand for coal, and hence the demand for labor to mine it. That means employment on full time for fewer men; in short, just the evil from which the anthracite region has for years been suffering.

From this point of view it is open to question whether the chief grievance of the miners against the operators is not after all the excessive rates charged for the carriage of anthracite to market, and the consequent cost to the consumer.

A fair estimate of the cost of coal on cars at the mines must include the following items:

1. Royalty on the coal in the ground.
2. Interest, depreciation and repairs of plant.
3. Cost of powder, tools, etc.
4. Cost of running the machinery.
5. Insurance against accidents to life and property.
6. Cost of superintendence.
7. Wages of skilled miners.
8. Wages of laborers and mechanics.
9. Profit of operators.

In a recent published statement of President Mitchell it is declared that the miners do not deny the right of capital invested in mining to receive a fair return, and ask only that labor may receive an equitable share of the profits.

If the miners are willing to accept a share of the risks, there is no reason why a share of the profits might not be allowed them. Indeed this has has been practically done in some industries where the wages have been based on a sliding scale varying with the selling price of the product.

It would be theoretically possible to do this in the anthracite industry by selecting a certain mine and setting aside a fixed sum per ton to cover items 2 to 5 inclusive. After deducting this sum from the price received for the coal the remainder should be divided on an equitable basis previously agreed upon between items 1, 6, 7, 8 and 9.

The practical success of such a profit-sharing system would be doubtful, but it would be an interesting experiment if one of the individual operators would try such a plan and it might lead to important results.

MINE VALUATION BY MINING EXPERTS.

There exists a very vague conception of what a mine really is, and an attempt to define a "mine" so as to distinguish it from a "prospect" or a "quarry" will at once make evident the truth of this statement.

Neither the geological origin of the mineral product nor the uses to which it may be put can be used as restrictive clauses or adjectives in the definition of the word "mine." Nor is the manner of working the deposit a criterion, for open-cut coal and iron mines are very common, while underground quarries are not unknown.

The distinguishing feature that marks the difference between a "mine" and a "quarry" is the comparative rarity of the respective products geologically considered. Salt, coal, leaf mica, iron ore, etc., are comparatively rare products, and being such may be spoken of as limited in volume. We think, therefore, that either the word limited or the word rare should enter into any exact definition of the term "mine" to differentiate it from "quarry."

Some clear distinction should also be made between the terms "mine" and "prospect," for so long as unexplored bodies of mineral are termed "mines" just so long will discredit and doubt attach to the mining business. We believe it, therefore, quite as essential to define the word "mine" as the term "ore in sight," and to use the word strictly as defined.

A "mine" may be defined as that part of a deposit of comparatively rare mineral which has been blocked out and explored by cuts, shafts, drifts, tunnels, inclines, or the like. If the mineral deposit has not been thus blocked out, it is a "prospect," and that part of a partially explored mineral deposit lying beyond the limits of the exploratory or development work is of prospective value, and should not be included as a part of the mine in estimating values; for no scientific valuation of a "prospect" is possible, and any attempt at such valuation is a mere guess.

The valuation of a "mine," however, is a problem easy of solution by a competent mining expert, so far as the elementary principles to be followed in the valuation are concerned. Of course in the application of these principles different experts will assign varying values to different quantities, and there may be large variations in the final results.

An example of these varying values was afforded in a paper read at the recent New Haven meeting of the American Institute of Mining Engineers by Dr. Rossiter W. Raymond, Secretary of the Society.

A certain copper mine had been estimated as having actually in sight sufficient ore to net $2,000,000 a year for five years, and the owners of the property asked $10,000,000 for it. Dr. Raymond's opinion was that the mine was actually worth not much more than half the price asked, even conceding the accuracy of the estimate of the ore in sight. In arriving at this conclusion his reasoning was as follows:

It is axiomatic that a sinking fund should be established, and such a part of the earnings of the mine should annually be placed in this fund, that compounded at the ordinary rate of interest on safe investments, say 4%, the amount at the end of the life of the mine will equal the purchase price. Second, the life of the mine should be assumed as being no longer than it would take to mine the ore in sight, which in this case was five years. Third, that the net annual profits on the investment, after deducting the sum set aside for the amortization fund, should be figured at not less than 20%. When his clients suggest 10% as being a fair annual return on such an investment, Dr. Raymond's reply always is that 10% can be earned on perfectly safe investments in the West, such as county and city bonds and warrants.

While we agree with the general proposition that a mine expert's valuation should be on the conservative side, it seems to us that Dr. Raymond's claim of 20% as a fair return on capital invested in mining can hardly be accepted in these days of low interest rates. It is true that county and city securities bearing 8 to 12% can be bought at par in some parts of the West, but only in very limited amounts, and they usually mature within a few months, or even weeks, necessitating the constant presence of a local agent to attend to presenting the paper for redemption and to the re-investment of the freed capital. To make the matter even worse, the paper usually carries on its face no date of maturity, but when funds sufficient to redeem it are in the treasury it is called in by a notice in the local newspaper, and after being so called in it ceases to bear interest. Should the paper by chance run several years, the interest is not paid until its maturity anyway, then being figured as simple and not as compound interest. It is evident, therefore, in view of these considerations, that after deducting the commission of the local agents a large investor will have little more than say, 6% net earnings from his capital even on 10% securities. There is, besides, the further fact to be considered that the total sum which could be so invested will be found to be a surprisingly small one. When Eastern capital invested in the West receives more than 4 to 6% it is because of two added factors; first the managerial item, second the item of risk. We have seen how the managerial item enters into the interest rates on Western collateral of the kind in question, and a brief consideration of this subject makes it also clear that the smaller the investment of capital in business the greater the relative cost of this very item—the cost of management. It frequently takes very little more time of a manager to look after an investment of $1,000,000 than one of $50,000. The smaller investment, however, would have to earn a nominal 10% to leave a net 5% if the manager received $2,500 a year as salary, while the larger million dollar investment by earning only 6% would still leave a net 5% after paying the manager $10,000 in commission or salary. Much more might be said on the subject, but it is hardly worth while, for in the great majority of cases it is not the province of the expert to tell his client what he ought to expect as interest on his capital. The capitalist's experience in such matters, as a rule, qualifies him to be more of an expert than the "expert," and—be it said in a whisper—he doesn't care a fig for the engineer's expression of opinion further than his expert knowledge of mining qualifies him to speak.

Coming now to the element of risk in mining, we are upon grounds where the expert must be consulted. First let us ask what the elements of risk are, by which we mean the risk of the engineer's estimate being too low as regards the cost of production, or too high as regards the yield of the mines. The sources of error appear to be:

(1) Error in estimating the number of tons of ore in sight.

(2) Error in getting a fair average sample of the ore.

(3) Error in estimating the costs of breaking down ore, hoisting, pumping, ventilating and timbering.

(4) Error in estimating the rates of wages that must be paid.

(5) Error in estimating the cost of milling and smelting and the accompanying losses of metal or mineral.

(6) Error in estimating transportation cost.

(7) Error in over-estimating the market price of the product, which is liable to fluctuations.

Since the mine is assumed to be a mine in the real sense of the term, the likelihood of committing serious error in (1) may be regarded as of no great importance if the mine valuer is of ordinary skill.

Error (2) in getting a fair sample of the ore is in some cases very slight, coal and iron for example; while there are classes of deposits where it is almost impossible to get a fair sample, as for example, the pockety deposits of cinnabar in some California mines. Except in the case of the more precious minerals, we may say that large errors in the sampling are not probable; and even in the case of deposits of precious metal, it is very often possible to get a close estimate, as illustrated in the working of some of the large hydraulic placer mines. In any case the expert should make clear in his report the extent to which his estimate of the quality can be relied on.

The development work should have reduced to a minimum the liability of erring in estimating the cost of drainage, etc., so that error (3) is of little moment.

Wages, of course, are liable to fluctuate in every line of business. Labor unions may, it is true, force the price of labor up, but so long as labor unions do not commit the folly of restricting a man's output, or of fighting labor saving devices,

it is quite certain that improved means of handling ores and treating them will offset any rise in wages. This statement is substantiated by the census statistics for coal and iron mining in the United States. Hence error (4) is practically eliminated.

The cost of concentrating and smelting an ore is, next to fair sampling, the most difficult part of the problem, since to ascertain the proper method of treatment may require much experimenting. The larger the investment to be made the more certain will be the accuracy in estimating this item, for where it would not pay to spend several thousand dollars in experimental work on an ore from a very small mine, it most assuredly would pay where the mine is a large one; so that the larger the mine the more certain is it that the cost of production will be susceptible of accurate estimate.

The cost of transportation is far more likely to decrease than to increase, so if assumed at existing rates there is very little chance for error (6).

Finally, coming to error (7) it may be said that all products fluctuate in price from year to year, the products of the mines no more than the products of the factory or the mill. The price is simply dependent upon the relation of supply to demand, in the long run being the cost of production in the poorest mines operated, plus fair profits. Since it is impossible to foretell just what the relation of supply to demand will be, and since all manufacturing ventures are upon just the same footing as mining in this respect, we may say that the expert is justified in assuming existing prices, leaving it to the capitalist to decide what to allow for this element of risk.

From the above discussion it would appear that so far as the expert is concerned the liability to err will depend entirely upon the particular mine he is estimating. From which it follows as a corollary that any general statement, such as that made by Dr. Raymond, to the effect that capital in mining should always have at least 20% net profit to warrant its investment, is not justified.

Abundant capital is seeking investment in these days, not only in investments where safety is assured, but in investments of greater or less risk, provided only that the return is commensurate with the risk. If the mine valuer does his work well, there will be as much or more chance that the property will turn out better than his estimate as that it will fall below it. Of course such investments are not proper for savings banks or the trust funds of widows or orphans, but the capitalist accustomed to take risks is often willing to balance the risk of gain against the risk of loss. It is the duty of the competent mine expert to present both these risks fairly to his client and leave him to decide as to their acceptance.

LETTERS TO THE EDITOR.

The Value and Significance of Certain Cement Tests.

Sir: In answer to a letter of Mr. H. A. Young, in Engineering News of Oct. 16, regarding the value of certain cement tests, I would state the following:

(1) The mere adherence of a pat of cement to a plate of polished glass should never be taken as a criterion of quality; this adherence being due more to the condition of the glass, and to the environment of the paste during setting and hardening, than to any property of the cement itself.

(2) The boiling test, when properly made and interpreted, often gives useful indications as to the quality of the cement. In the hands of inexperienced testers, however, it is worse than worthless, the results being often misleading and seemingly contradictory. Failure to pass this test can generally be attributed to one of three causes: (1) excess of lime; (2) insufficient seasoning; (3) coarseness of grinding. Or, since all cements contain some free or loosely combined lime, it may be stated that failure in this test is due to an excess of lime which has not had time or opportunity to become properly hydrated. If, therefore, a cement be allowed to season a week or two, it will usually pass the boiling test. Also, if the coarse particles of a cement be removed, the result will be similar. Where boiling tests of cement are made constantly, the amount of sulphate of lime present should be frequently determined, as an excess of this material will mask a considerable amount of lime, thus enabling an unsound cement to pass the test. Mr. Young's last case may possibly have come under this head.

(3) If Mr. Young would use the metric system of weights and measures, which is now employed by all the larger laboratories, he would have no difficulty in determining his percentages properly, and would save himself much annoyance. Yours truly,

W. Purves Taylor,
Engineer in Charge of Municipal Testing Laboratories,
City of Philadelphia.

Philadelphia, Pa., Oct. 21, 1902.

Protection of Steel Members of Highway Bridge Floors from Corrosion.

Sir: Many of our city bridges, especially those toward the outskirts of the city, have plank floors, but still carry a heavy traffic. Much of the drainage from the roadway on these bridges leaks through the floor on to the steel work below, and corrodes it very rapidly in spite of the paint. The idea had occurred to me that sheet zinc could be cut two or three inches wider than the flanges of the stringers—or floor beams, as the case may be—the edges bent down somewhat and the joists laid on top of it. It would prevent the roadway drainage from touching the steel work and thus effect an important saving. I would like to ask if you ever heard of that or any similar method being tried, and if so with what results? Was any injurious galvanic action set up between the steel and the zinc? The corrosion is much more rapid under the roadway than under the sidewalk. Did you ever hear of tarred paper being tried for that purpose? Very truly yours,

Willis Whited.

286 Main St., Pittsburg, Pa., Oct. 22, 1902.

(The question raised is worth the careful attention of engineers responsible for the care of highway bridges. These parts under the floor and difficult of access are too often neglected by both inspectors and painters. We should apprehend no danger whatever of galvanic action from the use of zinc, and even if it should occur the zinc and not the steel would suffer. We see no reason why the zinc would not be an excellent thing for stringers and floor beams, but we do not see how it could be readily applied to make a workmanlike job for the protection of bottom chords and bottom lateral rods. We shall be glad to hear from any readers who have found a satisfactory solution for the problem suggested by our correspondent.—Ed.)

The Flattest Concrete-Steel Arch in the World and Some Other Flat-Arch Bridges.

Sir: We have recently received a little leaflet from the National Bridge Co., of Indianapolis, Ind., illustrating a concrete-steel arch bridge which they recently built at Columbian Park in Lafayette, Ind. In this leaflet they emphasize the statement that this is "the flattest elliptical arch bridge in the world." In the interests of reliable statistics, we beg publicly to correct this error. Elliptical arch bridges have recently become much more common than formerly, owing to the difference in the modern materials of construction and the consequent greater facility in complying with rigid conditions of grade and clearance. There have been built recently quite a number of elliptical arch bridges, in which the ratio of rise to span has been less than engineers would formerly have considered safe. We have not data at hand for many of these, but we beg to call attention to one of the eight elliptical arches which were finished about a year ago under our supervision at Zanesville, O., in the celebrated Y-bridge. (Eng. News, March 27, 1902.)

These eight spans were all constructed by the Thacher system, with flat steel bars containing rivets, placed at intervals in the intrados and extrados of the arch rings. The following table will indicate the ratios of rise to span in the various arches:

Length, ft.	Rise, ft.	Ratio.
122.0	11.5	.094
122.0	14.6	.120
122.0	14.6	.120
120.5	11.5	.096
99.0	6.24	.063
81.0	14.8	.182
81.0	10.85	.134
81.0	6.1	.075

As the span referred to by the National Bridge Co. has a span of 40 ft. and a rise of 4 ft., making the ratio of rise to span 0.1, it will be seen that all of the eight spans at Zanesville are larger and heavier in every way than the one at Lafayette. The Zanesville spans were all designed for heavy electric railroad traffic as well as floor load of 125 lbs. per sq. ft.

While we know of no other elliptical arches of such low ratios, there have been constructed at various times several circular or segmental arches which are interesting on account of their flatness. A railroad bridge at Bourbonnias, France, built of cut granite by Vandray, has a span of 125 ft. and rise of only 6.9 ft.; one built over the Oise River at St. Maxence in France by Perronet during the latter part of the 18th century has a span of 76.1 ft. and a rise of 6.5 ft., and another at Nemours by the same engineer has a span of 53 ft. and a rise of 3.8 ft. A [illegible] over the Oignon at Pesmes, in France, built by Bert[illegible] has a span of 45 ft. and a rise of 3.8 ft.

These and several other noted structures have a [illegible] ratio of rise to span than that of the arch bridge at Lafayette, but they are, as above noted, circular and not elliptical. We believe that the 99-ft. span at Zanesville, with its ratio of rise to span of 0.063 is the flattest elliptical arch in the world, but we would be glad to be corrected in this if we are in error.

We would say in regard to this span as of all others at Zanesville that they are remarkably rigid and are doing their work in an excellent manner. No excessive movements occurred upon or after striking the centers and no serious cracks developed at that time or since. Yours truly,

The Osborn Engineering Co.
Bernard L. Green.

Cleveland, O., Oct. 21, 1902.

Forms of Ball Joints for Submerged Water Mains at Atlantic City, N. J.—Corrections and Additions.

Sir: In your issue of Oct. 23, you describe the forms of ball joints for submerged water mains at Atlantic City, N. J., and state that the form shown by Fig. 1 was the form used some years since, and that the new pipes are as shown by Fig. 2. These numbers are reversed.

In this connection I would say that the original submerged pipe at Atlantic City was a 12-in. main, and the form of joint used was the regular foundry pattern. This main was laid in 1882, and has remained in good condition since it was laid. In 1889 a 20-in. main was laid, and from that time until 1896 constant repairs were necessary, and the main was always leaking more or less. In 1896 new pipe was purchased, and again a standard foundry pattern was used, but the pipe was cast at two foundries, and after delivery it was found that each foundry had used its own pattern and that the two patterns were materially different. These patterns are the ones shown in Fig. 2 of the article referred to. In laying this pipe it was necessary to lay across the entire 500-ft. channel and connect at each end to the existing main. Time was short, and no provision was made for putting pressure on the pipe from time to time as it was laid. The result was that when pressure was put on this pipe, it buckled slightly in places.

Two years later it was found that owing to some dredging done nearby, part of this pipe had settled and pulled apart. Some ball-joint pipe with flanges was then procured, and a slip joint, and were placed in this main. To provide against further settlement, the main was supported on a single row of piling, two piles to each 12-in. pipe, the top of the pile receiving a cast-iron cap with saddle in which saddle the pipe rested. When the repairs had been made and pipe placed in the saddles the water was turned on and the pipe buckled, and some two or three lengths were forced entirely out of the saddle. The slip joint was then shortened and the pipe replaced in the saddles, where it remained, but one joint, which owing to the difference in pattern of the original pipe and the ball joints used in making the repairs had an excessive lead-room, gave considerable trouble by leaking. There were one or two other joints which leaked at times also.

When the new main was laid at Atlantic City in 1901, the writer decided, as the result of the experience with the former one, to lay it in sections about 100 ft. long, with a flange on each end. These sections were put together on a platform supported on piling above water and then lowered into place, where a diver made up the flange joint. A blank flange was then bolted on the end of the pipe and 50 lbs. pressure applied, which brought the ball joints to firm bearing and took up all lost motion in them. The result of this method was that after connecting up and turning the water on there was no buckling.

The design of the joint should be credited to the consulting engineer, Mr. Emil Kuichling, M. Am. Soc. C. E., who made the suggestions and sketches from which the writer made the drawings for the joint. Very truly yours,

W. C. Hawley, Assoc. M. Am. Soc. C. E.

Wilkinsburg, Pa., Oct. 25, 1902.

(The error due to transposition of the titles of the illustrations is so obvious that we have no excuse to offer. We are pleased to be able to give the fuller and more complete account of the Atlantic City ball joints which Mr. Hawley has so kindly sent to us. As we stated in the article, Mr. Hawley was formerly engineer and superintendent of the Atlantic City water-works.—Ed.)

A Problem in Refunding Bonds.

Sir: I think it would be of general interest to your readers if your mathematical editor would give a general formula for problems similar to the following:

Bonds, each for $1,000, are to be issued to the amount of $1,000,000; the bonds bear interest at 5%, payable semi-annually. At the end of 3 years, and at the end of each year thereafter, such a number of these bonds is to be paid, at 105%, that the whole issue shall be paid in 20

years. How many of the bonds will have to be paid annually in order that the sum of the annual charge for the interest and the payment of bonds shall be an equal amount for each of the 18 years, i. e., the 3d to the 20th each included? The accumulation for the payment of the bonds is not to bear interest.

It appears at first sight as if this problem should be easily solved by some combination of the methods used for annuities and compound interest, but I have submitted the problem to a number of young men who are graduates of technical schools and none of them have been able to give a general formula for such a problem.

Yours truly, "Novice."

Boston, Mass., Oct. 11, 1902.

(Our interpretation of the problem presented is stated below, together with the solution. It will be seen that a straight algebraical method leads to the result directly.

Bonds are issued, n in number, of a face value of A each. They bear interest at rate r. At the expiration of x years a number n_x of these bonds is retired, being bought at a price which bears the ratio R to the face value A. At the end of each year thereafter bonds in number,

$$n_{x+1},\ n_{x+2},\ \ldots\ n_y,$$

are retired, so that at the end of y years the entire issue of bonds is completely refunded. In any year the interest on the bonds still out, plus the sum paid for bonds retired at the end of that year, equals a constant amount K; the first (x − 1) years are, of course, an exception to this. The problem is: find the sum K, and the number of bonds retired at the end of successive years, i. e., the numbers,

$$n_x,\ n_{x+1},\ \ldots\ n_y.$$

The conditions of the problem say that,

for year x, $K = n\,A\,r + n_x\,A\,R$; (1)

for year (x + 1), $K = (n - n_x)\,A\,r + n_{x+1}\,A\,R$; (2)

similarly $K = (n - n_x - n_{x+1})\,A\,r + n_{x+2}\,A\,R$; (3)

etc., until $K = (n - n_x - \ldots - n_{y-1})\,A\,r + n_y\,A\,R$; (4)

and $0 = (n - n_x - \ldots - n_y)\,A\,r + 0$. (5)

Then, subtracting (2) from (1), we get,

$$0 = n_x\,A\,(R + r) - n_{x+1}\,A\,R, \text{ or } n_{x+1} = n_x\,\frac{R+r}{R}$$

$$\text{Similarly, } n_{x+2} = n_{x+1}\,\frac{R+r}{R} = n_x\left(\frac{R+r}{R}\right)^2$$

$$\text{and, finally, } n_y = n_x\left(\frac{R+r}{R}\right)^{y-x} \quad (6)$$

If we subtract (5) from (4) in the same way, we find,

$$K = n_y\,A\,(R + r). \quad (7)$$

Combining (6) and (7), the equation for K becomes,

$$K = n_x\,A\,(R + r)\left(\frac{R+r}{R}\right)^{-x} \quad (8)$$

$$\text{But from (1), } \quad n_x = \frac{K - n\,A\,r}{A\,R} \quad (9)$$

which, substituted in the preceding equation (8), yields,

$$K = (K - n\,A\,r)\left(\frac{R+r}{R}\right)^{y-x+1},$$

whence,

$$K = n\,A\,r\,\frac{\left(\frac{R+r}{R}\right)^{y-x+1}}{\left(\frac{R+r}{R}\right)^{y-x+1} - 1}. \quad (10)$$

Since equation (10) contains K as the only unknown, it determines this quantity. The value of n_x is then given at once by equation (9). The other terms for the number of bonds retired at successive periods, the values

$$n_{x+1},\ n_{x+2},\ \ldots\ n_y,$$

are obtained by successively multiplying n_x by the term $\frac{R+r}{R}$. As a check, the value of n_y may be calculated directly from equation (7). It is evident that the computation from the formulas is greatly facilitated by the use of logarithms.

Applying our general formulas derived above to the concrete problem of "Novice," we have the known values.

$n = 1{,}000.$ $\quad x = 3.$
$A = \$1{,}000.$ $\quad y = 20.$
$r = 0.05.$
$R = 1.05.$

Then, from (10),

$$K = 50{,}000\,\frac{\left(\frac{1.10}{1.05}\right)^{18}}{\left(\frac{1.10}{1.05}\right)^{18} - 1} = \$88{,}169.$$

using this value in (9),

$$n_x = \frac{88{,}169 - 50{,}000}{1{,}050.} = 36.35.$$

The other terms are obtained by multiplying successively by the factor 1.0476. The last lot of bonds retired, n_y, is found to number 80.15, which value is checked by the equation (7).

It may be mentioned that in case it is desired to begin to accumulate a sinking fund from the very first year, other formulas must be derived. The same method as used above will give the solution, but the resulting equations are more complex.—Ed.)

Notes and Queries.

F. L. B. asks whether any tests have been made to determine the strength of the joint of cast iron brazed by the new process described in our issue of Oct. 16.

The American Brazing Co. informed us that the brazed joint is stronger than the cast iron itself; in proof of which they show samples that have been fractured by a hammer blow, wherein the fracture partly follows the line of the brazing, and then passes through the cast iron itself. We are not informed as to results of direct tensile tests.

RAILWAY PILE DRIVERS.*

We find a very wide range of opinion as to the requirements of an ideal pile driver, but believing the ideal machine to be the one with the greatest adaptability to all of the various kinds of work required in the construction and maintenance of railways under all conditions,we would make of it the following severe requirements, all of which we do not find any one machine to possess, but which we do believe possible to combine in one, without making it unduly complicated.

1. It should be able to drive piles of any length and size from either end of car, close to the car, or 15 ft. ahead of wheelbase as may be desired; either plumb or at any desired batter (within reasonable limits), and at any point of a circle the radius of which shall be equal to half the length of the car. It should swing itself into the proper position for the pile by power from its own engine under the control of both the engineman and signalman at any time during the operation of raising, setting, or driving pile, without interfering with any other part of the work; being at the same time rigid enough to perfectly hold the largest pile used in the heaviest kind of permanent construction work, and yet sensitive enough to be susceptible of the slightest move at the will of the operator.

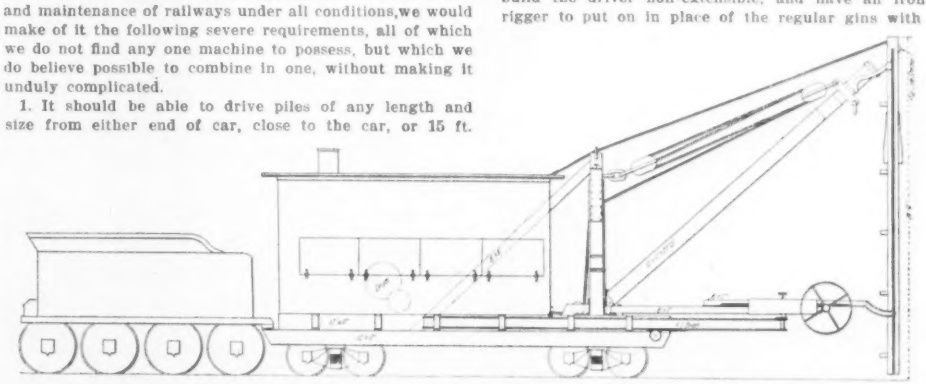

FIG. 1. COMBINED PILE DRIVER AND DERRICK CAR, ILL. CENT. R. R.

2. It should be rigged with a boom long and strong enough to handle with ease and safety the heaviest bridge timber, as well as to do all the work usually required of a steam derrick car in the erection and maintenance of bridges, culverts, etc. It should also have a capacity for heavy lifting, making it very useful in clearing up a wreck, pulling out temporary structures and old bridges, and, in fact, doing any kind of work where a strong portable steam derrick is required.

3. Its construction should be such as to make all the changes necessary to adapt it to all the various kinds of work required of it in the least possible time with a very small force of men, and so simple that no great amount of special training will be needed to fit ordinary bridge men to handle it successfully. It should not require more than six men, including engineman, for all ordinary work.

Such a machine might easily be constructed by combining the best features of the various machines and thus secure a pile driver that would be able to accomplish a maximum of service at a minimum of cost. While there may be a very wide difference of opinion expressed in the following extracts, they are mostly on details of construction rather than on the essential features of operation; and many of these may arise largely from prejudice from the use of one special type of machine, which with a larger experience might entirely disappear. Therefore, we believe that a careful study of the various drivers, both as to construction and range of work possible to each, will be very beneficial.

We might, perhaps, call attention to the great difference for the requirements of a machine to economically perform the work being accomplished by the B. & M. R. R. pile driver in building a pile bridge to replace a wrecked truss bridge in dead of winter; and that for a machine to economically perform the work being accomplished by the Illinois Central R. R. combined derrick car and pile driver, in building falsework under a through truss bridge, erecting bridges, etc.

B. F. Pickering, A. W. Merrick, A. B. Manning, C. C. Mallard, W. M. Noon, W. T. Powell, Committee.

APPENDIX.

H. E. Eggleston (C., C., C. & St. L. Ry.).—The Bay City pile driver is the ideal, but it should reverse to drive from either side of car 15 ft. ahead of wheelbase. Turning should be done by hand, as engineman can keep driving while leaders are moved to suit piling. It should be able to drive 10 ft. from center of track. Leaders should be raised by steam in 15 to 30 seconds. It should have hammer weighing 3,200 lbs., using 1½-in. manila rope. Batter of piles can best be done by swinging the leaders. The ideal machine should be able to drive piling, handle all kinds of bridge timber and materials, and load same on cars.

J. P. Snow (B. & M. R. R.).—The ideal pile driver is one that can be used for all purposes of maintenance, and that can be adapted on occasion for building new work where there is no existing track. Should be usable inside an ordinary through bridge. Should reverse and drive from either end of car. The cases where an extension driver is needed are so rare that it seems best to build the driver non-extensible, and have an iron outrigger to put on in place of the regular gins with comparatively short leaders. This would leave the driver simple and rigid for regular use. The best method of turning driver on car is by rack and pinion driven by the engine through the medium of a friction connection. It should be able to drive 16 ft. from center of track. Best method of hanging leaders is by hinge at top of frame, with bolted connection at car body level. A rolling rocker has the advantage of compactness, but its complexity outweighs the gain. Raise leaders by line from engine winch head attached to lower end of leaders, time about 1 min.; length of leaders about 45 ft.; weight of hammer, 3,000 lbs., using 2-in. manila rope. It should be rigged with boom so that shift can be quickly made. Batter can be secured without either tilting car or swinging leaders; swinging leaders not advisable.

W. T. Powell (Colorado Southern Ry.).—Pile driver should be on permanent extension and able to drive 20 ft. ahead of wheelbase with swing leaders, and able to drive at either end of car and driver to be swung by some kind of steam power; should not be self-propelling; should be able to drive at right angles with track; leaders should be hung on an A-frame so made that it can be lowered with leaders; length of leaders, 40 ft.; weight of hammer, 3,000 lbs.; 2-in. manila rope; should not be rigged with boom; 30-HP. engine; would batter piles by swinging leaders.

M. Riney (C. & N. W. Ry.).—Should extend 16 ft. beyond trucks, and engine swing with leads; would raise leaders by crab one to two minutes; length of leaders, 38 ft.; weight of hammer, 2,200 lbs.; should be rigged with boom.

Arthur Montzheimer (C. & N. W. Ry.).—It should be self-propelling, be able to take a 35-ft. pile under the hammer, reversible so as to drive either way, with plenty of boiler capacity; should be able to drive 16 ft. ahead of wheelbase; should turn with screw and cranks as on Bay City driver or by steam from driver engine; should drive 14 ft. from center of track; would hang leaders on pivot similar to the C., M. & St. P. Ry.; would raise leaders

*Abstract of a committee report, presented at the annual convention of the Association of Railway Superintendents of Bridges and Buildings, Minneapolis, Minn., Oct. 21 to 24. The report illustrates and describes a number of pile drivers, including those of the C., M. & St. Paul Ry. and the Industrial Works, described and illustrated in our issue of Nov. 16, 1899.

by use of crab; time, 4 mins.; length of leaders, 40 ft.; weight of hammer, 3,000 lbs.; 3-in. manila rope; wire does not last well; should be rigged with boom; 24-HP. engine; swinging leaders not necessary to batter piles; a steam hammer would be a good improvement.

H. M. Henson (Boston & Me. R. R.).—The best track driver I have handled was a Bay City driver with swing leaders, and with locomotive headed on to driver, with steam connection from locomotive to driver engine, and taking steam direct from locomotive to driver engine. In this way you save the cost of fireman on driver and always have plenty of steam to drive pile. When you are using boiler on driver, and have to hit a pile 100 to 150 blows to get the proper penetration you get out of steam and have to stop and wait for fireman to get more steam; but if you are taking steam from locomotive you can just keep on driving. I have never seen a self-propelling pile driver that was a success; they are too slow and break down easily.

W. H. Woodard (Southern Ry.).—I have recently been using the Vulcan pile driver built at Chicago, and like it better than the Bay City pile driver, on account of driving better piles. The Vulcan pile driver hammer frame works on a pivot near top of main frame, and will drive batter piles as well as plumb posts. The Bay City will swing the leads badly unless you guy it on curves where you are driving batters. The Vulcan has a follower that stays with the pile, and has a jump block that top hammer strikes instead of striking the pile direct. The only trouble with this is in keeping the blocks, as the top hammer bursts them very quickly. The jump block should be of solid rubber instead of wood, as it would last longer. Another matter that can be made better is the gage frame at the bottom where you throw the hammer frame out for driving batters; this should have pinholes every 6 ins. in order to drive batters at any degree you want them. None of them will drive batters the same on a curve, as the inside of the curve will not have batter enough and the oitside will have too much batter.

A. S. Markley (C. & E. Ill. Ry.).—The machine we have been using for the past ten years was built by the Industrial Works, Bay City, Mich. There is but one objection, and that is the direction of the pile line from the drum to top of leads; if this line were run over a sheave on the same shaft as the hammer line, it would, in my opinion, be a perfect driver, though the present mode of hoisting piles is not detrimental to the driver. This driver is self-propelling, and will run at a speed of eight to ten miles an hour, and pull on a level grade five cars, and is equipped with steam brake.

The driver is equipped with engine tank similar to locomotive for hauling coal and water on one end, and pilot car on the other. Half of the pilot car is a flat car which runs under the leads when moving in train from place to place, and the other half is converted into a tool car to carry supplies for the driver, and for the enginemen to sleep in. Underneath the driver, on a suspended platform, the pump is located and connected to boiler with suction pipe, to pump water from streams when within reach of pump into tank of driver, to avoid running to water stations for water.

The length of our leads is 47 ft., the weight of hammer 2,900 lbs. We use 2-in. manila rope. The time in raising the lead is not to exceed 2 mins., when everything is ready, and we can drive about 12 ft. from center of main track. The pile driver engine is 30 HP., double cylinder. The engineman and fireman are the only two special men with the driver; the former we pay $2.50, and the latter $1.50 per day.

Cost of Driving Piles; Spring, 1902 (C. & E. I. Ry.).

No. of piles driven.	Length of—Shortest pile.	Length of—Longest pile.	Aggregate lin. ft. piles driven.	Cost of driving.	Cost per ft. of pile.
74	14	36	1,302	$139.92	$0.107
14	14	22	260	23.97	.092
14	14	22	250	14.01	.056
18	14	26	360	12.62	.035
34	18	36	1,000	24.30	.024
18	16	20	336	8.57	.025
8	14	14	112	8.75	.078
16	14	27	300	8.75	.029
14	14	24	280	8.75	.031
16	16	26	336	8.75	.027
16	16	22	304	8.75	.029
24	18	28	564	16.02	.028
88	18	36	2,773	95.45	.034
62	18	42	1,800	66.50	.037
8	22	24	286	10.62	.037
12	22	24	272	10.62	.039
436	14	42	10,535	$466.35	.....
Avg.27	14	42	658	20.08	$0.044

The above costs are taken from our books. In two cases the costs per ft. runs 9 and 10 cts. for driving. These bridges were a great distance (3 miles) from the sidetrack.

We also use the pile driver for unloading material where we have concrete or stone work to do. If the sidetrack is very far away and the job is a large one, we put in a temporary track, and use the pile driver, under the direction of the concrete foreman.

It is very rarely that we use a locomotive for handling our pile driver; in certain cases where the jobs are very short and a long way from a sidetrack, it is advisable then to use a locomotive in order to save time. Where the jobs are very large and the sidetrack a great distance away from the bridge, it is sometimes best to put in a temporary sidetrack especially for them, to avoid using a train.

In driving piles with the driver, there is no train crew provided; our own bridge foreman gets the orders and the dispatchers in turn protect the driver between the stations where they are working against all except first-class trains. This has been our practice for the past ten years and in all that time there has not occurred a single accident to the driver by coming in conflict with trains.

The point has been raised several times that a train crew or a conductor, at least, should be sent to look out for the driver and to see that it was kept out of the way of the regular trains. The argument raised by the transportation department that bridge foremen were not competent to handle pile drivers on the main track, was always met by the argument that if a bridge foreman is competent to tear out a bridge, thus making it possible to ditch an entire train, he was certainly competent to handle a pile driver on main track driving piles, which is true in every particular. Of course, flagmen are always out when the driver is on the main track, this in addition to protection given by train dispatchers.

It is often the case when train men are used to handle work trains and trains of similar nature, they are figuring on when they can go to sidetrack, and just how long they can lie there and not be criticized by their superior officers, thus delaying the work unnecessarily. This can be overcome by a good bridge foreman who will watch closely and keep the work going. We do not confine ourselves to one particular foreman; each foreman does his own work on his own division. We are charged $2.10 per hr. for a train and crew.

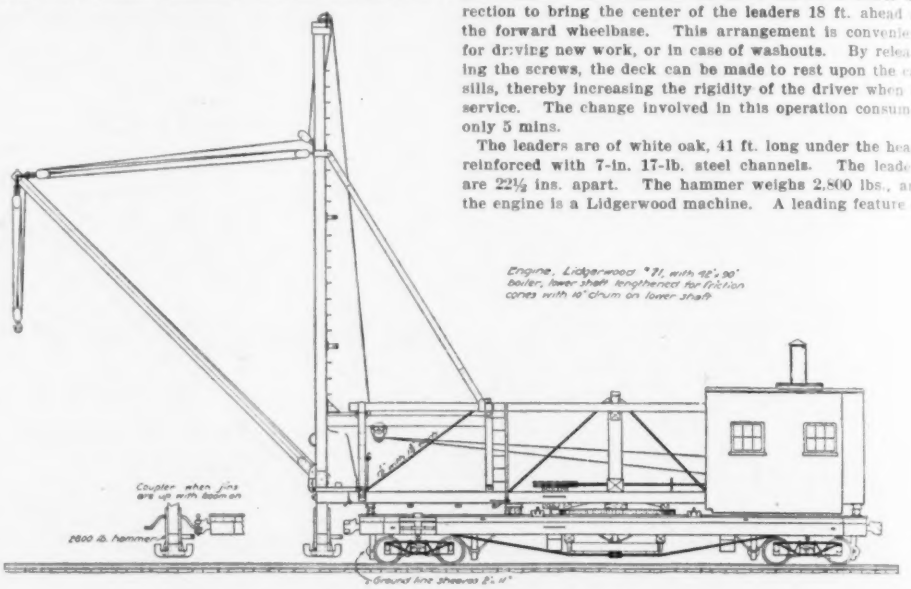
Engine, Lidgerwood "21, with 12"x 20" boiler, lower shaft lengthened for friction cones with 10" drum on lower shaft
Coupler when pins are up with boom on
2800 lb. hammer
Ground line Sheaves 8'-4"

FIG. 2. PILE DRIVER, BOSTON & MAINE R. R.

COMBINED DERRICK CAR AND PILE DRIVER; ILL. CENT. R. R. (Designed by Mr. O. J. Travis, Superintendent of Bridges).—This type of machine (Fig. 1) has been used principally for the erection of steel and iron bridges, and has a lifting capacity of 30 tons. Steel plate-girders of large pattern are handled with the derrick, in setting out ahead, with rapidity and safety. The derrick is also used for erecting truss spans up to 150 ft. in length, without the use of a traveler. This method of bridge erection has been employed quite frequently during the last five years, travelers being used only on exceedingly long spans. There is a heavy A-frame, with a boom made from a 12 × 12-in. timber, 27 ft. long. The pile driver leads are hinged at the end of this boom, and to steady them at the bottom there is an extension strut, which can be run forward by means of a hand wheel and rack. In some of the machines, however, this feature takes the form of a telescoping pipe which can be adjusted to the requirements imposed by the angle of the boom. This pipe is hinged at the foot of the boom, and in swinging the boom to the side of the track the adjustment of this extension brace is not altered. There is also a pair of 9-in. I-beams reposing in guides along the side sills of the car. These I-beams are connected by a cross beam at the front end, and can be run forward by means of a crank and cog rack. The pile driver leads range from 18 to 24 ft. in length. These leads are formed by 4 × 6-in. angles riveted back to back.

Bridge men engaged in the erection of steel bridges appreciate what a convenience it is to get a pile driver inside of a through-truss span to drive falsework for the renewal of the structure. With this machine the work is reduced to a simple matter, as no lateral or other braces have to be removed. The boom of the machine is simply lowered; the machine enters the bridge and can be set to work in a few minutes. The advantage of being able to raise the boom to increase the height of the pile-driver leads is apparent. In addition to the use of the machine for bridge erection and pile driving purposes, it has also been found an excellent wrecking derrick. On numerous occasions the transportation department has sent for the machine to be handled by experienced bridge men in clearing up wrecks.

PILE DRIVER; BOSTON & MAINE R. R.—The machine (Fig. 2) was built on ideas worked out by Mr. [illegible] Pickering, Supervisor of Bridges and Buildings, [illegible]ville, N. H. The car is 40 ft. long by 9 ft. wide. The car body is made up with two 10 × 12-in. side sills, two 8 × 10-in. center sills, and four intermediate sills, [illegible] 6 × 10-in.; all except the side sills are reinforced with 8-in. channels bolted to the sides. Four of these channels are allowed to project 2 ins. above the top line of the side sills, to serve as guides for the extension deck, on which the superstructure rests. The four center sills are plated on top with ¼ × 6-in. iron. There are six 1½-in. truss rods with upset ends. The car is mounted upon diamond frame trucks, the bolsters of which are allowed to extend the full width of the car, being provided with nuts in their ends and 3-in. screws for adjusting the car to any level. The car is equipped with air brakes.

The car body proper is not planked over, the planking being on the extension deck, which is composed of sills 6 ins. deep and of a width to correspond to that of the sills of the car, having two cross beams bolted to the top of the sills, each 5½ ft. from the center, carrying screws to raise the extension deck on two steel rollers which run on the plated sills. This deck can be easily moved in either direction to bring the center of the leaders 18 ft. ahead of the forward wheelbase. This arrangement is convenient for driving new work, or in case of washouts. By releasing the screws, the deck can be made to rest upon the car sills, thereby increasing the rigidity of the driver when in service. The change involved in this operation consumes only 5 mins.

The leaders are of white oak, 41 ft. long under the head, reinforced with 7-in. 17-lb. steel channels. The leaders are 22½ ins. apart. The hammer weighs 2,800 lbs., and the engine is a Lidgerwood machine. A leading feature of the design of this pile driver is that the turning is done entirely by engine power, thus saving the labor of two to four men and accomplishing the work in a more satisfactory manner than when done by hand. The turning movement is under the control of either the engineman or the signalman at all times, without stopping the hammer, which renders it possible to drive piles at any point within a circle of 45 ft. diameter without moving the car. The driving apparatus operates equally well from either end of the car, and only 4 mins.' time is required to reverse from one end of the car to the other. This movement is accomplished by means of a circular rack, 9 ft. 4 ins. diameter, bolted securely to the center circle rail, in which runs a pinion operated by worm gear, which, in turn, is driven by friction cones on the lower drum shaft of the engine.

The manipulation is by means of an operating lever in the engine room and on the forward end of the driver frame. By this manner of turning greater power and greater speed is obtained than by hand turning. As the worm gear holds rigidly wherever it is left this arrangement allows the signalman to easily make all the lateral changes necessary while driving a pile without stopping the hammer. To drive piles at a batter, the car is tilted by means of the screws in the end of the truck bolster, a few turns being all that is necessary to secure the desired batter. These screws also serve as extra side bearings when the driver is being used as a steam derrick.

For lifting purposes, the driver is equipped with a boom, making the machine a convenient derrick. To increase the stability of the car when used for such purposes there are eight rail clamps and stiff legs. The machine has repeatedly handled objects weighing from 10,000 to 20,000 lbs., 32 ft. from the center of the track, without difficulty. For wrecking purposes the car is equipped with a shorter boom, by means of which objects can be lifted weighing about double the above figures. When used as a derrick the frame of the driver is securely clamped to the car. Another advantage in the way of stability when being used as a derrick is the heavy construction, the machine complete

weighing 100,500 lbs. The height of the machine folded for shipment is 14½ ft.

R. H. Reid (L. S. & M. S. Ry.).—We have recently had a pile driver built for us by Kaltenbach & Griess, of Cleveland, after designs furnished by us. This machine has given excellent service and has more good points and fewer objectionable features than any pile driver I have ever seen. It was patterned largely after one we built in our own shops several years ago after my own ideas, the details being worked out in our drafting room. My idea of the best pile driver is one which will work close to the end of the car when necessary, where 75% of the driving is done, as in ordinary renewals, repairs, etc., and which can also be made to drive 16 ft. ahead for building new work, taking care of washouts and similar work where we have to build as we go. It is also desirable to have a driver that will work on both ends of the car, to avoid as far as possible turning the machinery in working on different jobs. It is also desirable to be able to drive piles as far out from the center of the track as practicable in order to take care of foundations, second track, trestles, etc.

I think it should be able to drive piles 20 ft. from the center of the track on which it stands. It should be self-propelling, and move itself easily and quickly for short

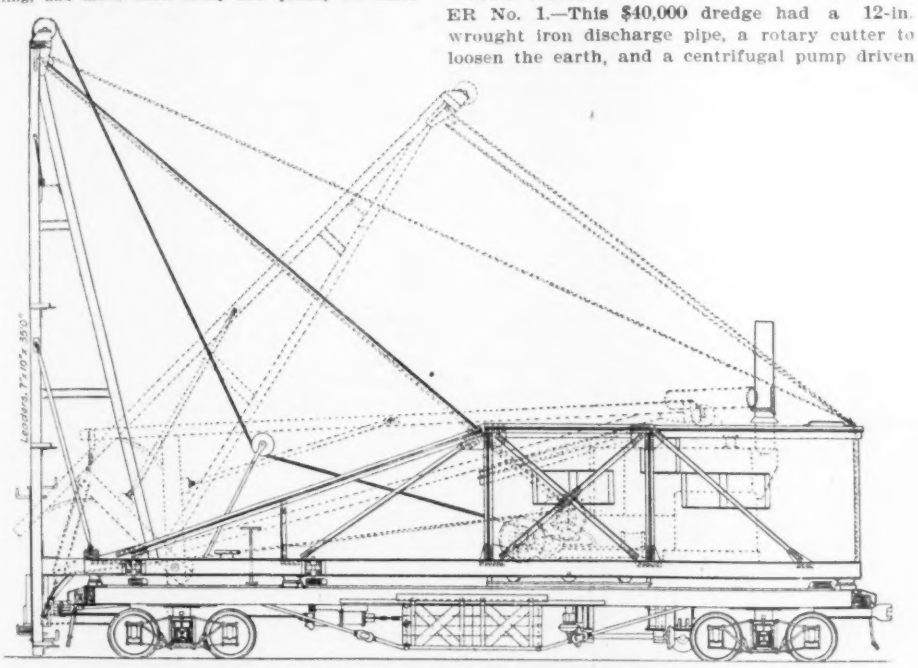

FIG. 3. LAKE SHORE & MICH. SOUTHERN RY. PILE DRIVER.
Built by Kaltenbach & Griess, Cleveland, O.

movements, as well as for ordinary running, and should be able to raise and lower the leaders by steam. I do not advocate pendulum leaders, but prefer to point a draw on the piles, and draw in the tops to give them batter. The car should be as short, narrow, and low as is practicable to make it and still have it carry the necessary machinery and equipment, so that it may be used in close places and pass under low bridges. In regard to the best method of turning driver on the car, I think a rack at the front end of the car and a pinion on each of the sills for swinging and holding the leaders is the best. My driver will raise and lower the leaders in less than 3 mins. for each operation. The leaders should be from 36 to 40 ft. long and the hammer weighs from 3,000 to 3,500 lbs. This would require 1¾-in. manila rope, or ⅞-in. steel cable. It is often desirable to have a driver rigged with a boom to use as a derrick, and mine is so equipped. We have handled all the iron in the erection of a 105-ft. span Pratt truss bridge, carrying it out to place and holding it there while it was being connected, the bridge being built alongside of the main track. I do not consider 100,000 lbs. excessive for a pile driver complete, as I have two which weigh more than that, and it requires a pretty heavy weight to hold the driver firmly on the track, in holding large piles and a heavy hammer. On the other hand there are occasions where a light driver is desirable, as in work on new track on soft ground, or on very old bridges where there is much old timber.

My pile drivers fill all the conditions mentioned above as being desirable in a driver; they will drive close to the end of the car at one end and will reverse and drive 16 ft. ahead at the other end, the center of the table being about 6 ft. nearer one end of the car than the other. The leaders raise and lower with steam; they will drive 20 ft. out from the center of the track on which they stand. The machines are self-propelling; will move themselves easily, and will run at a speed of 10 miles on ordinary track. One 35-HP. engine handles the piles and hammer, and propels the car. About the only improvements I could suggest in this driver as a result of something over a year's experience with the new one, would be heavier sills and stiffer upper truss for the sills to prevent rocking.

THE COST OF DREDGING ON THE MASSENA CANAL.

A description of the great hydraulic power canal in St. Lawrence County, N. Y., appeared in our issue of Dec. 16, 1897, when the work upon it had just begun. Later and more complete information regarding the work and the plant employed are to be found in our issues of Dec. 15, 1898, and Feb. 21, 1901.

From a recent paper read before the International Navigation Congress by Mr. John Bogart, M. Am. Soc. C. E., we have abstracted the following data of cost of dredging on the Massena canal. Mr. Bogart was Engineer-in-Chief of the St. Lawrence Construction Co., and had charge of the construction of the canal. We shall not here repeat description of the plant given in our former issue:

COST WITH CENTRIFUGAL PUMP DREDGER No. 1.—This $40,000 dredge had a 12-in. wrought iron discharge pipe, a rotary cutter to loosen the earth, and a centrifugal pump driven by a Ledgerwood compound condensing engine of 125 HP. The material was lifted 30 ft. above water level, and the discharge average was 25% of solid material, the range being 7 to 30% of solid. The dredge could not operate in indurated clay, but handled soft clay, loam and sand. It worked rain or shine, six days a week ,two shifts of 11 hrs. each, for about 8 months each year for three years, excavating 459,800 cu. yds. It cut to a depth of 22 feet below water surface, and discharged the material through 1,200 ft. of pipe. The crew, each shift, was 1 captain, 1 engineman, 1 oiler, 1 fireman, 1 deckhand foreman, 3 laborers at 15 cts. per hour. The total pay of this crew of eight men for 11 hrs. was $17.95. Assuming the annual depreciation and repair item at 10% of the cost of the dredge we have $4,000, to which must be added 4% of the cost for interest on the investment, or $1,600, making a total of $5,600, which, divded by 209, the actual number of double shift days worked each year, amounts to $26.80 per day. Summing up, we have for the daily cost of operation:

Labor and supervision	$35.90
Nine tons coal at $3	27.00
Oil, waste, etc	5.00
Interest, repairs and renewals	26.80
Care during winter $209	1.00
Total for 22 hours	$95.70

Very careful observations extending over 194 days showed an average daily output of 1,125 cu. yds. of earth per day of 22 hrs., so that dividing $95.70 by this output we have 8.5 cts. per cu. yd. as the average cost. The cost without the interest and renewal item was 6.035 cts. per cu. yd.

COST WITH CENTRIFUGAL PUMP DREDGER No. 2.—This dredge, which cost $60,000, had an 18-in. suction and discharge pipe and was in every way like Dreedger No. 1 except in being larger. The material and distance to which it was moved were the same also. It required one more man, a spudman, and the total wages per 11-hr. shift were $20.95. This cost included placing and taking care of the discharge pipe. Assuming the same rates of interest and depreciation as before we have for the daily (22-hr.) cost of operation:

Labor and supervision	$41.90
18 tons coal at $3	54.00
Oil, waste, etc	8.00
Interest and renewals	40.19
Care during winter	1.00
Total for 22 hours	$145.09

The dredge worked two seasons and excavated 290,780 cu. yds., the actual average being 1,544 cu. yds. per day of 22 hrs., making the average cost 9.4 cts. per cu. yd., which is nearly one cent more than with dredge No. 1.

COST WITH DIPPER DREDGE.—A dipper dredge, having a 2½ cu. yd. bucket, excavated indurated clay to a depth of 20 ft. below water surface, depositing the material in two scows, each having a dropping pocket with a capacity of 140 cu. yds. A tugboat towed the scows 5,500 ft. to the St. Lawrence River, where they were dumped. Since towing could not be done at night, only one shift of 10 hrs. was worked each day. The dredge, tug and two scows cost $43,000. Interest at 4% is $1,720 per annum. One-tenth for repairs and renewals is $4,300. These distributed over the days actually worked (212) each year would be $28.80 per day of 10 hrs. The daily wages of the crew of dredge, tug and scows, plus the coal, supplies, etc., amounted to $30.56 for each day of 10 hrs. Hence:

Labor, supervision, coal and supplies	$30.56
Interest, repairs and renewals	28.80
Care during winter	1.00
Total per day of 10 hours	$60.36

This dredge averaged 754 cu. yds. per day of 10 hrs. for 183 days, making the average cost 8 cts. per cu. yd. on the basis of $60 a day above given. Neither the centrifugal pump nor the orange-peel bucket dredges could excavate the indurated clay and boulders handled by this dredge, and where excavated dry with steam shovels the material had to be blasted. A 1½-cu yd. dipper dredge worked one season and the cost per cu. yd. of material moved was also 8 cts. A 6-cu. yd. dipper dredge showed practically the same cost per cu. yd., although no exact records of its performance were kept.

FAILURE OF THE VACUUM ORANGE-PEEL DREDGE.—A specially designed dredge having a rotary cutter for loosening the clay, which was then to be handled with a 4-cu. yd. orange-peel bucket, was an economic failure in the indurated clay, and was made over into dredge No. 2, above described. It could move the softer material, but the vacuum means of transmission failed to handle the material with economy, the clay forming into balls in the hopper and not remaining suspended in the water. In closing, we would call attention to the error that we think occurs in making an allowance of about 200 working days per annum for a dredge. There are idle years in the life of most large dredges that greatly reduce the average productive output. This over-estimate of the average number of days per annum actually worked is in a measure counterbalanced by the liberal estimate of 10% for repairs and renewals. In view of the fact that so large a part of the cost of a dredge is the cost of the hull, which certainly has a much longer life than ten years, we think that the 10% is too high an allowance. Moreover, when we consider the fact that the interest on the annual allowance for depreciation itself becomes a large item when compounded for a term of years we are well on the side of safety in saying that 10% annually is a very high allowance for dredge repairs and renewals.

RAILWAYS IN INDO-CHINA, which is a French colony, have been authorized under a presidential decree, by which the government of the colony may raise a loan of $13,500,000. The arrangements for construction will be made through the Minister of the Colonies, at Paris, France.

TIMBER PRESERVING PLANT OF THE ALAMOGORDO LUMBER CO.

We have recently referred to the fact that a number of plants are now being built and projected for the purpose of applying preservative treatment to railway ties, bridge timbers, paving blocks, electric light poles and timber generally. One of the latest of these plants is that put in operation on June 3 at Alamogordo, N. M., for the Alamogordo Lumber Co., of which Mr. C. D. Simpson is President, Mr. Charles B. Eddy, Vice-President, and Mr. S. S. Hopper, General Manager. This plant is intended particularly for treating ties and bridge timbers by the Wellhouse (zinc-tannin) process, and has a capacity of 5,000 ties per day, continuous working. Contracts for supplying these ties have already been made with the Mexican Central Ry., Fort Worth & Denver R. R., and other railways. The plant was designed by Mr. Samuel M. Rowe, M. Am. Soc. C. E., Consulting Engineer, 226 La Salle St., Chicago, and we are indebted to him for plans and other information. The general plan is shown in Fig. 1.

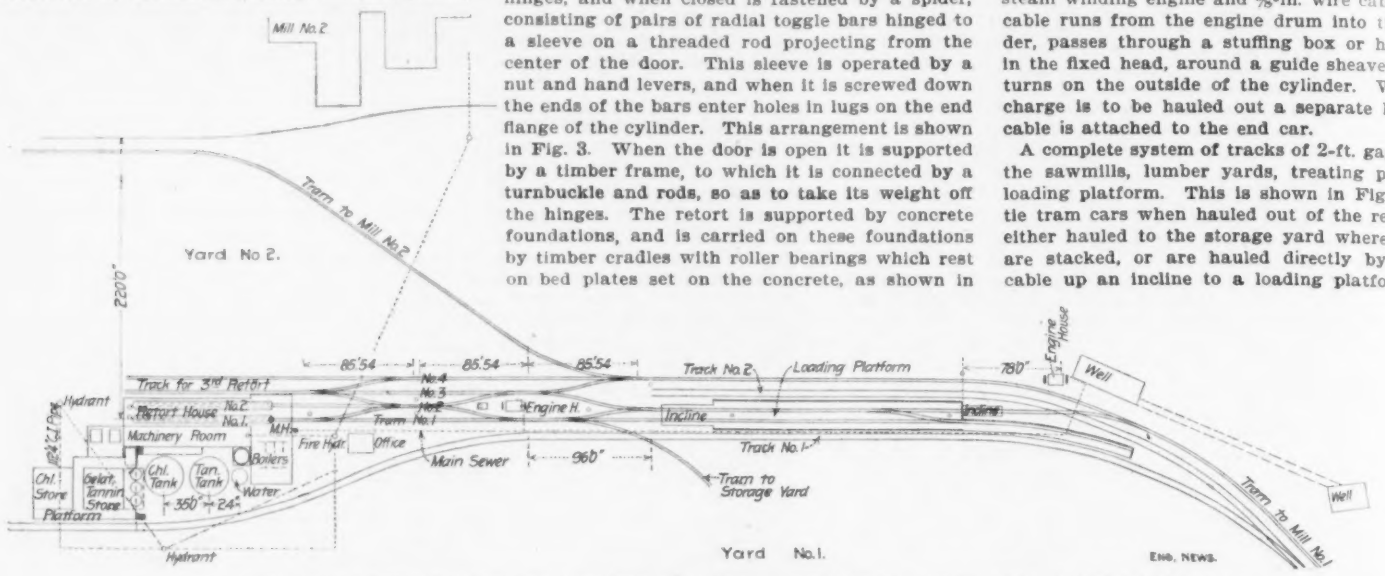

FIG. 1. PLAN OF TIMBER PRESERVING WORKS FOR THE ALAMOGORDO LUMBER CO., ALAMOGORDO, N. M.
Samuel M. Rowe, M. Am. Soc. C. E., Chicago, Consulting Engineer.

DESCRIPTION OF THE PLANT.

There are two steel cylinders or retorts, and the plant is arranged for a third retort. These retorts are of ⅝-in. steel of 60,000 lbs. tensile strength, with 24 cylindrical courses 6 ft. diameter inside and outside, as shown in Fig. 2. Each course consists of a single sheet 4 ft. 10 ins. wide and 20 ft. long. The circumferential seams are single-riveted and the longitudinal seams double-riveted. Each retort is 106 ft. long and has a 20-in. drainage drum at the bottom. It has a fixed hemispherical head at one end and a dished or concave door at the other end. The door is hung on heavy hinges, and when closed is fastened by a spider, consisting of pairs of radial toggle bars hinged to a sleeve on a threaded rod projecting from the center of the door. This sleeve is operated by a nut and hand levers, and when it is screwed down the ends of the bars enter holes in lugs on the end flange of the cylinder. This arrangement is shown in Fig. 3. When the door is open it is supported by a timber frame, to which it is connected by a turnbuckle and rods, so as to take its weight off the hinges. The retort is supported by concrete foundations, and is carried on these foundations by timber cradles with roller bearings which rest on bed plates set on the concrete, as shown in Fig. 4. The two cradles at the middle of the retort are anchored to the concrete foundations, the cylinder expanding and contracting towards either end.

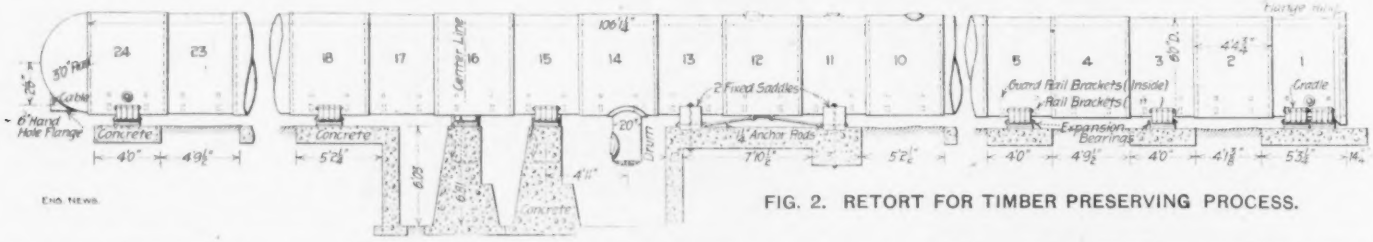

FIG. 2. RETORT FOR TIMBER PRESERVING PROCESS.

In each retort is a track of 2 ft. gage, Fig. 5, the rails being carried on brackets to which they are secured by soft steel clamps hammered over upon the rail flanges after the rails are laid. Above the track rails are guard rails which project over the platforms of the tie cars, and so prevent the latter from floating or shifting when the retort is filled with the preservative solution. The length is designed for 13 cars with 8-ft. ties. There are about 32 large hewed ties to a car, or 42 sawed ties; thus a charge will consist of about 350 hewed or 570 sawed ties. The tie trams or cars are of steel, while long timbers are carried by trucks fitted with swiveling bolsters on which the timbers rest, thus allowing the cars to pass the sharp curves of the yard tracks. The ties are chained upon the cars. These cars are hauled in and out of the cylinder by a 30-h.p. steam winding engine and ⅝-in. wire cable. The cable runs from the engine drum into the cylinder, passes through a stuffing box or hand hole in the fixed head, around a guide sheave, and returns on the outside of the cylinder. When the charge is to be hauled out a separate length of cable is attached to the end car.

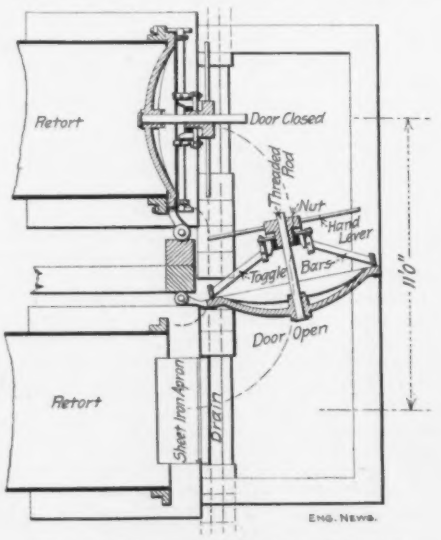

Fig. 3. Door and Fastenings of Retort.

A complete system of tracks of 2-ft. gage serves the sawmills, lumber yards, treating plant and loading platform. This is shown in Fig. 1. The tie tram cars when hauled out of the retorts are either hauled to the storage yard where the ties are stacked, or are hauled directly by another cable up an incline to a loading platform, 4 ft. above the ground. On each side of the platform is a standard gage track for railway cars, into which the ties are loaded. One of these tracks also extends to the treating plant, for the delivery of cars of coal and supplies. The loading platform has three rows of brick piers with concrete footings; across the piers are cap timbers 12 × 12 ins., 22 ft. long, carrying joists 3 × 12 ins., 10 ft. long; these are 23 ins. c. to c., with double bridging pieces between. Under the rails of the tie tram track the joists are 6 × 12 ins., 24 ins. apart. Upon the joists is a flooring or deck of 3-in. plank.

The retort house is 32 × 132 ft., with an extension 32 × 145 ft., forming the boiler room. This contains three tubular boilers of 84 HP. Parallel with the retort house is the machinery room, 16 × 100 ft., containing the pumps, pipe connections, etc. There are two wooden solution tanks, 30 × 20 ft., of 100,000 gallons capacity; one for the chloride-gelatin solution and the other for the tannin solution. Alongside the boiler room are the feed-water tanks, 12 ft. diameter, and the cooling tower, with its tank of the same dimensions. Beyond the solution tank are three circular tanks in which the glue and tannin are dissolved. The vat house contains one vat, 10 × 10 ft., 2½ ft. deep, in which the zinc chloride is dissolved, but provision is made for a second vat, as shown on the plan. The concentrated solution is then piped to a storage vat, 8 × 12 ft., 3½ ft. deep. The three vats are of wood, lined with sheet lead ½-in. thick. Compressed air is used to agitate the solutions in all the vats and tanks in order to expedite the dissolving of the materials and to keep the materials in suspension.

The pipe system is somewhat complicated, as it includes steam and vacuum pipes, compressed air pipes, two sets of solution and blow-back pipes, steam heating pipes, condenser circulating pipes, water pipes for pumps, etc. This necessitates careful arrangement for convenience of inspection or repair, and also careful grouping of the nu-

merous valves, so that they may be conveniently handled during the various processes by the man in charge of the plant. The retorts, tanks, and store rooms, etc., are supported by concrete foundations, and the machinery is enclosed within wooden buildings lined inside with matched boarding.

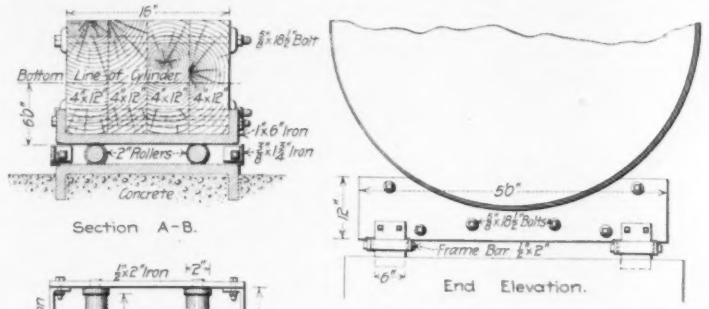

FIG. 4. CRADLE AND EXPANSION BEARINGS FOR RETORT.

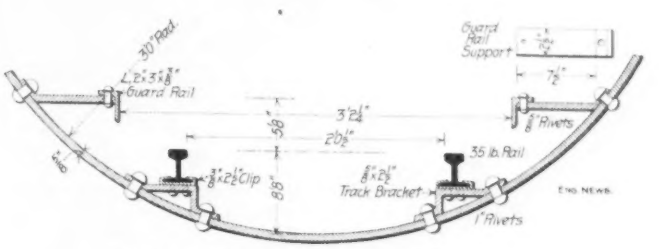

FIG. 5. CROSS-SECTION OF RETORT.

The duplex vacuum pump, duplex pressure pumps, boiler feed pumps, force and service pumps, and the air compressor for forcing the solutions back from the retorts to their tanks are all of the Knowles pattern. City water under high pressure is used for the boilers and solution tanks and for fire purposes. In order to economize in the consumption, as the charge for water is high, the fire and service pumps of the plant are used to force the cooling water through the condenser to the top of the cooling tower, which is 8 ft. square and 30 ft. high, mounted on a wooden tank, 12 × 12 ft., 14 ft. high, with a capacity of 10,200 gallons. The tower, Fig. 6, has a series of horizontal floors of planks with narrow openings between the planks, the openings being staggered in alternate floors. Through these openings the water drips, being cooled by the air as it falls. A screen of weather boards, with inclination inward, is used to deflect the water and prevent the wind from blowing the water and spray out of the tower. This tower effects a difference of 15° to 20° F. between the temperature of the water as delivered at the top and drawn off at the bottom. There is a thermometer on each retort and on each of the solution tanks, so that the operator may know at what temperature the solution stands in each. Heating coils are provided in the pipe pits, boiler feed tank and the solution tanks. The chloride is received in kegs weighing 1,000 lbs., and these are handled by a trolley carrier fitted with differential hoist.

The general construction was done by the company. The retorts were built by the Scully Steel & Iron Co., of Chicago. The pumps and compressor were all supplied by the Knowles Steam Pump Co., of New York, and the hoisting engines by the Lidgerwood Mfg. Co., of New York. The solution tanks and the tram cars were built by Fairbanks, Morse & Co., of Chicago; and the pipes and fittings were supplied by the John Davis Co., of Chicago.

DESCRIPTION OF THE PROCESS.

There are no superheating pipes or coils in the retort, but the first stage of the process is to admit live steam at 250° F. into the retort. This is as high a temperature as can be carried without injury to the wood, and corresponds to a pressure of about 20 lbs. The steam is kept on from two to five hours, according to the condition of the timber, this being a matter of judgment. The water of condensation is blown out from time to time, and samples of this are taken, the steaming being continued until these appear measurably clear from sap. The steam is then blown out to the open air, and the cylinder is allowed to partially cool. A vacuum of about 23½ ins. is then created, and is maintained for about an hour. This causes the softened and dissolved sap and vapor to be drawn out, and the condensation to fall into the hot well, so that the vapor will not interfere with the operation of the vacuum pump. The extent to which it is possible to raise the vacuum varies, of course, at different plants, according to their height above sea level.

When the vacuum has been continued for a sufficient time it is still maintained, and the chloride solution is run in by gravity from the elevated tanks. A pressure of 100 lbs. per sq. in. is then created by force pumps. This pressure is retained for two to four hours. Very little of the solution is forced into the timber after the first hour, but the pressure must be maintained until the requisite quantity has been forced in. This averages from 1 to 1¼ lbs. per tie, or 0.25 to 0.33-lb. per cu. ft. for sawed ties and 0.3 to 0.5-lb. per cu. ft. for hewed ties. At the new tie-preserving plant of the Great Northern Ry., at Kalispell, Mont., which was also designed by Mr. Rowe, the requirement is for 0.50 to 0.75-lb. of pure chloride per cu. ft. of timber.

A chloride solution of from 1½% up to even 4% in some cases is used, and with it is mixed the gelatin (made by dissolving commercial glue) which eventually seals the cells of the wood. This is done for the reason that the chloride is a solvent of glue, and the latter, therefore, penetrates much deeper into the wood when applied in this way than it would if applied as a more or less viscous solution. At other plants, however, the chloride, glue, and tannin solutions are applied separately. When the chloride treatment is finished, the solution in the cylinder is forced back into the gravity tank by air pressure of about 15 or 20 lbs. The tannin solution is then admitted from another tank, and a pressure of 100 lbs. maintained for about 1½ hours. This solution is about 0.5% in strength, or 1.005% of extract, which extract generally consists of 25% tannic acid. The tannic acid or tannin enters into chemical combination with the glue, forming leathery pellicles (usually called "leatheroid") which seal the wood against the leaching out of the solution or the entrance of moisture.

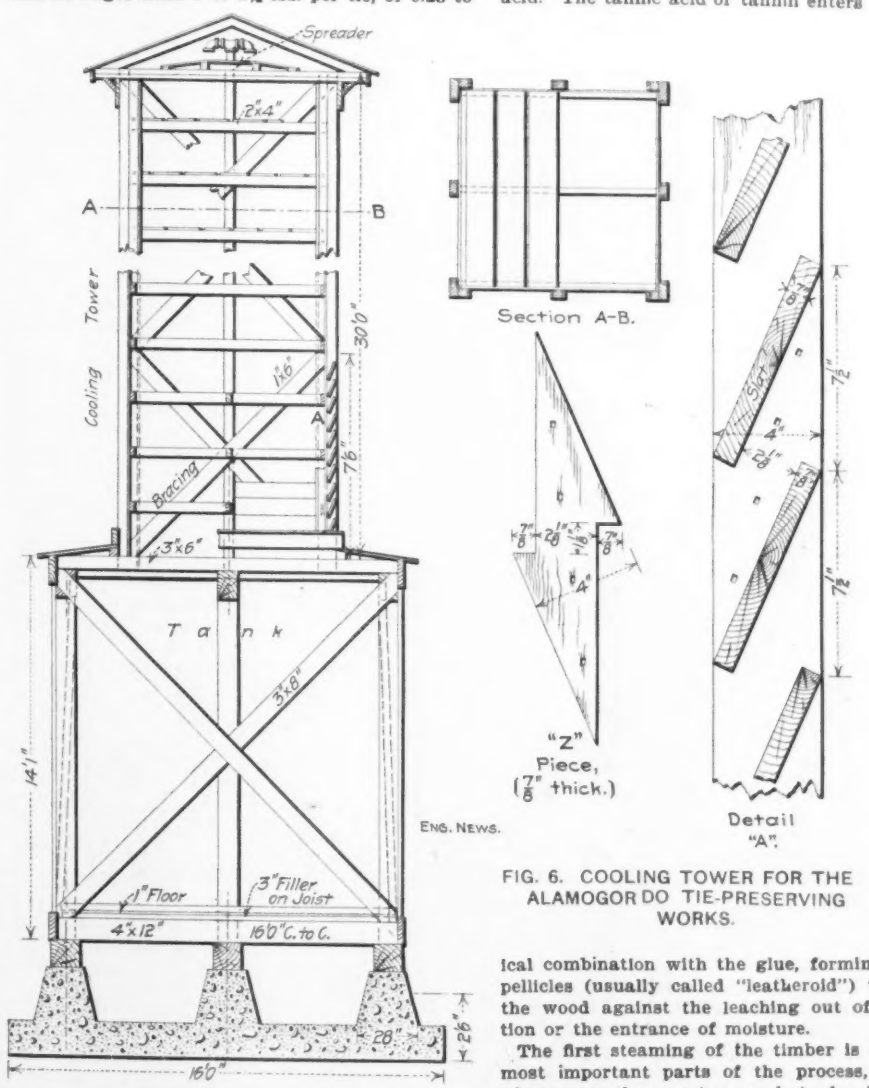

FIG. 6. COOLING TOWER FOR THE ALAMOGORDO TIE-PRESERVING WORKS.

The first steaming of the timber is one of the most important parts of the process, as it not only causes the sap to run, but also breaks up the conditions which would lead to fermentation and fungus growth. Thus, the steaming alone, if properly carried out, would probably increase the life of the timber. The voids in the green timber form about 0.4% of its volume, as an average; but after steaming it will take up solution enough to represent 20 or 35% of its volume.

No laboratory or chemical work is required in operating the plant. The strength of the chloride solution is fixed, and its strength at any subse-

TIMBER PRESERVING PLANT OF THE ALAMOGORDO LUMBER CO.

We have recently referred to the fact that a number of plants are now being built and projected for the purpose of applying preservative treatment to railway ties, bridge timbers, paving blocks, electric light poles and timber generally. One of the latest of these plants is that put in operation on June 3 at Alamogordo, N. M., for the Alamogordo Lumber Co., of which Mr. C. D. Simpson is President, Mr. Charles B. Eddy, Vice-President, and Mr. S. S. Hopper, General Manager. This plant is intended particularly for treating ties and bridge timbers by the Wellhouse (zinc-tannin) process, and has a capacity of 5,000 ties per day, continuous working. Contracts for supplying these ties have already been made with the Mexican Central Ry., Fort Worth & Denver R. R., and other railways. The plant was designed by Mr. Samuel M. Rowe, M. Am. Soc. C. E., Consulting Engineer, 226 La Salle St., Chicago, and we are indebted to him for plans and other information. The general plan is shown in Fig. 1.

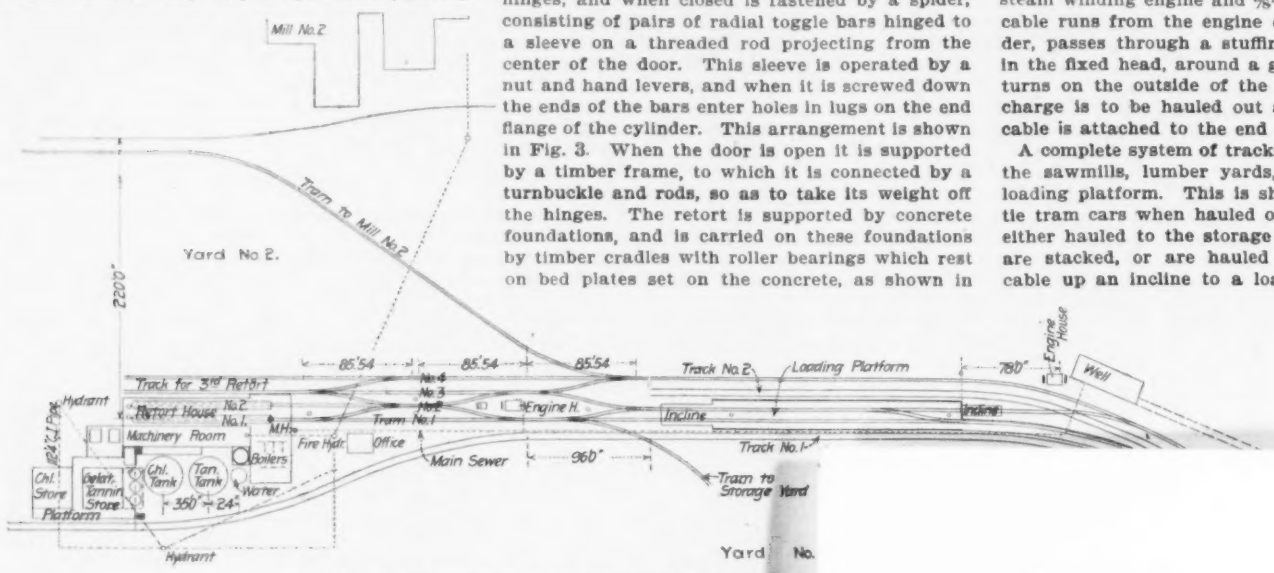

FIG. 1. PLAN OF TIMBER PRESERVING WORKS FOR THE ALAM
Samuel M. Rowe, M. Am. Soc. C. E., Chicag

The timber used is mainly mountain pine, with fir and a little spruce, the timber being brought in on a logging railway 30 miles long to the company's lumber yards, where there are two sawmills. The best wood is used for bridge and other structural work, the inferior quality being used for ties. The ties are stacked for two months to dry, if this time can be allowed, but they are sometimes sent direct from the sawmills to the treating plant, although in such cases the effect of the treatment is not so good. After treatment, they may be shipped at once if necessary. About 30 men are required to operate the plant during the day, most of these being engaged in loading and unloading ties. At night only five or six men are required for charging and emptying the retorts—an engineman, fireman and three or four men to fasten and unfasten the doors, and run the charges in and out of the retorts.

DESCRIPTION OF THE PLANT.

There are two steel cylinders or retorts, and the plant is arranged for a third retort. These retorts are of ⅝-in. steel of 60,000 lbs. tensile strength, with 24 cylindrical courses 6 ft. diameter inside and outside, as shown in Fig. 2. Each course consists of a single sheet 4 ft. 10 ins. wide and 20 ft. long. The circumferential seams are single-riveted and the longitudinal seams double-riveted. Each retort is 106 ft. long and has a 20-in. drainage drum at the bottom. It has a fixed hemispherical head at one end and a dished or concave door at the other end. The door is hung on heavy hinges, and when closed is fastened by a spider, consisting of pairs of radial toggle bars hinged to a sleeve on a threaded rod projecting from the center of the door. This sleeve is operated by a nut and hand levers, and when it is screwed down the ends of the bars enter holes in lugs on the end flange of the cylinder. This arrangement is shown in Fig. 3. When the door is open it is supported by a timber frame, to which it is connected by a turnbuckle and rods, so as to take its weight off the hinges. The retort is supported by concrete foundations, and is carried on these foundations by timber cradles with roller bearings which rest on bed plates set on the concrete, as shown in Fig. 4. The two cradles at the r
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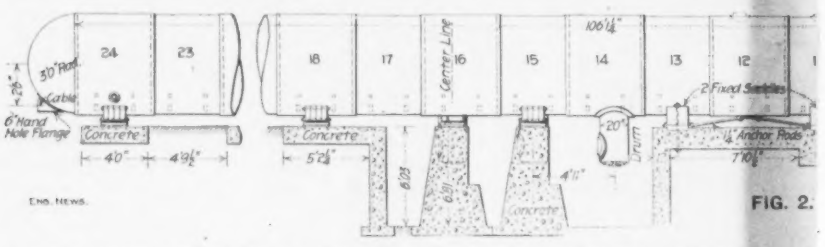

FIG. 2.

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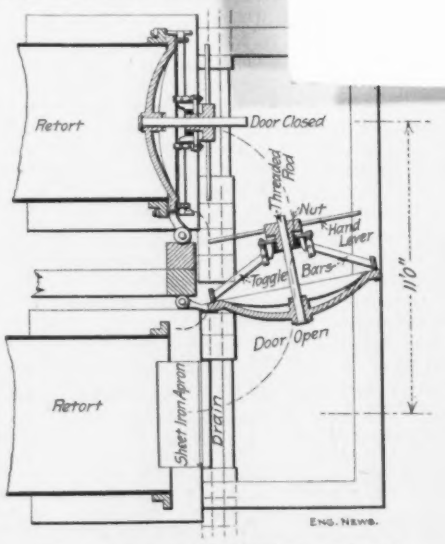

Fig. 3. Door and Fastenings of Retort.

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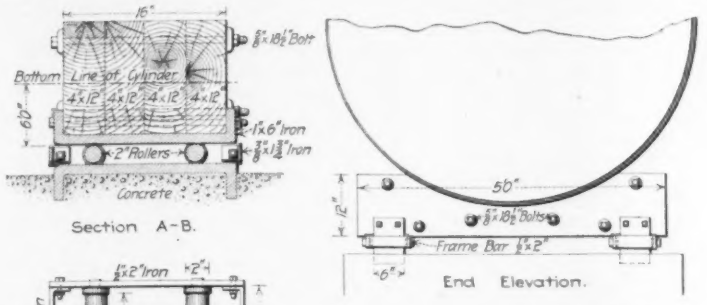

FIG. 4. CRADLE AND EXPANSION BEARINGS FOR RETORT.

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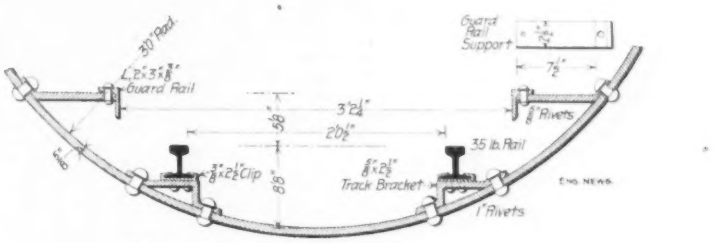

FIG. 5. CROSS-SECTION OF RETORT.

is done for the reason that the chloride is a solvent of glue, and the latter, therefore, penetrates much deeper into the wood when applied in this way than it would if applied as a more or less viscous solution. At other plants, however, the chloride, glue, and tannin solutions are applied separately. When the chloride treatment is finished, the solution in the cylinder is forced back into the gravity tank by air pressure of about 15 or 20 lbs. The tannin solution is then admitted from another tank, and a pressure of 100 lbs. maintained for about 1½ hours. This solution is about 0.5% in strength, or 1.005% of extract, which extract generally consists of 25% tannic acid. The tannic acid or tannin enters into chemical combination with the glue, forming leathery pellicles (usually called "leatherold") which seal the wood against the leaching out of the solution or the entrance of moisture.

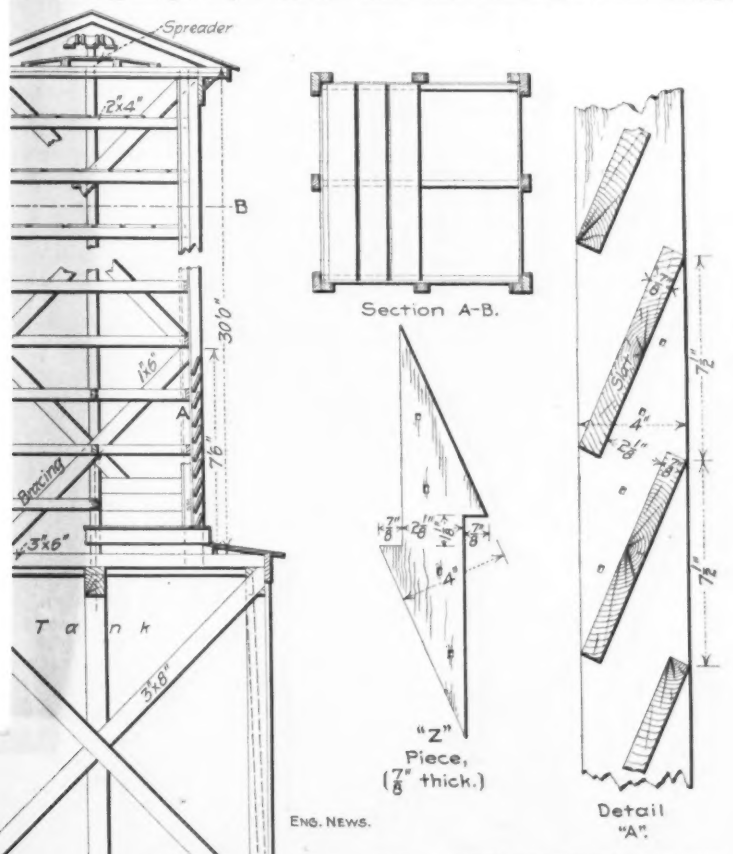

FIG. 6. COOLING TOWER FOR THE ALAMOGORDO TIE-PRESERVING WORKS.

0.33-lb. per cu. ft. for sawed ties and 0.3 to 0.5-lb. per cu. ft. for hewed ties. At the new tie-preserving plant of the Great Northern Ry., at Kalispell, Mont., which was also designed by Mr. Rowe, the requirement is for 0.50 to 0.75-lb. of pure chloride per cu. ft. of timber.

A chloride solution of from 1½% up to even 4% in some cases is used, and with it is mixed the gelatin (made by dissolving commercial glue) which eventually seals the cells of the wood. This

[illegible] Co., of New York, and the hoisting [illegible] Lidgerwood Mfg. Co., of New York. The solution tanks and the tram cars were built by Fairbanks, Morse & Co., of Chicago; and the pipes and fittings were supplied by the John Davis Co., of Chicago.

DESCRIPTION OF THE PROCESS.

There are no superheating pipes or coils in the retort, but the first stage of the process is to admit live steam at 250° F. into the retort. This is as high a temperature as can be carried without injury to the wood, and corresponds to a pressure of about 20 lbs. The steam is kept on from two to five hours, according to the condition of the timber, this being a matter of judgment. The water of condensation is blown out from time to time, and samples of this are taken, the steaming being continued until these appear measurably clear from sap. The steam is then blown out to the open air, and the cylinder is allowed to partially cool. A vacuum of about 23½ ins. is then created, and is maintained for about an hour. This causes the softened and dissolved sap and vapor to be drawn out, and the condensation to fall into the hot well, so that the vapor will not interfere with the operation of the vacuum pump. The extent to which it is possible to raise the vacuum

The first steaming of the timber is one of the most important parts of the process, as it not only causes the sap to run, but also breaks up the conditions which would lead to fermentation and fungus growth. Thus, the steaming alone, if properly carried out, would probably increase the life of the timber. The voids in the green timber form about 0.4% of its volume, as an average; but after steaming it will take up solution enough to represent 20 or 35% of its volume.

No laboratory or chemical work is required in operating the plant. The strength of the chloride solution is fixed, and its strength at any subse-

quent time is ascertained by means of the hydrometer by the man in charge. All the tanks are fitted with float gages, and just before the solution is admitted to the retort, the height at which it stands in the tank is noted, as shown by the indicator. After the treatment the solution is forced back to the tank and the indicator again read. The difference between the readings shows the amount absorbed by the timber, tables being prepared showing the number of cubic feet in the tank for each mark on the indicator. The number and size of ties or timbers in the charge being unknown, the cubic contents are ascertained by subtracting the volume of the solution forced back to the tank from the known volume of the retort. Subtracting this from the total amount of solution used gives the amount absorbed by the charge, and this divided by the cubic contents of the charge gives the average absorption per cu. ft. All quantities are expressed in cubic feet, no gallon measurements being used. The practice of weighing the timber before and after treatment does not give correct information as to the amount (or weight) of solution absorbed, since it does not take into account the extraction of sap by the steaming and vacuum process, the amount thus extracted being unknown.

The ties at these works are inspected before treatment, and are also marked before treatment by a 4-lb. hammer or die, like a spiking maul; having on the lower end raised figures 5-16-in. high. There are 13 hammers to a set, one having the last figure of the year, and the others numbered 1 to 12 (in smaller figures) for the months. The imprint is marked on the end of the tie by a swinging blow, and ties can be marked as fast as a man will strike.

THE DESIGN OF STREET RAILWAY TERMINALS.

The design of terminals for street railway lines is an engineering problem which is coming up with increasing frequency. Many electric railway companies draw a heavy traffic from portions of their lines extending from a city to some outlying resort, such as a beach, parade ground, fairground, or park. It frequently becomes necessary to handle on such lines an extraordinarily heavy traffic. At the close of an evening entertainment, for example, a crowd of thousands all make at once for the cars, and the proper handling of such a crowd with safety and a reasonable degree of comfort is largely dependent on the design of the terminals.

So far as we are aware, the best solution of the problem of rapid handling of crowds at a street railway terminal was furnished by the Buffalo Ry. Co., in its terminals provided for handling the crowds at the Pan-American Exposition last year. We have therefore thought it worth while, even though that exposition is a thing of the past, to describe and illustrate these terminals.

From the accompanying sketch map, which is not drawn to scale, it will be seen that there were three loop terminals for the electric street railway cars. The larger one, outside the West Amherst Gate, was approached by two parallel double track lines and had two separate loops, each of which had four passenger tracks parallel with Amherst St. and also a series of stub tracks for storing cars. Outside the East Amherst Gate was a double track loop with four stub tracks, and a little distance from this were two other stub tracks (for storing cars) between the main running tracks. On the north side was a third loop, connecting with the Hertel Ave. electric line, and passengers using this terminal passed under the railway station of the exhibition by a subway, marked A on the plan. The railway station had nine tracks, running into a four-track main line which extended from the west end, and into a double-track main line extending from the east end of the station. The two north tracks in the station were for the Erie Ry., and the others for the New York Central Ry. Access to the island platforms was afforded by the subway marked B on the plan.

The arrangements of the three street railway terminals were planned on the principle of avoiding all back-up movements at the terminal, and also of breaking up the crowds and so preventing the concentration which in such cases leads to confusion, delay and perhaps danger, with the added troubles of getting people on the wrong cars and encouraging pickpockets. Thus at the West Amherst Gate, 16 different cars on the eight straight tracks of the loops could be taking on passengers at the same time, each car having its own little crowd and being far enough from the next car to keep the crowds apart. Meanwhile, other cars could be arriving or leaving without interfering with the crowds to any extent. The further tracks had, of course, to be reached by grade crossings, but the cars moved slowly, and as the crowd was scattering instead of concentrating there was very little danger. The tracks were separated by wire fences, with double gates at the crossings, where watchmen were stationed. The platforms between the tracks were about 24 ft. wide (tracks 33 ft. c. to c.) there was plenty of room for the people to disperse without continual fear of the cars, as might be the case with tracks close together. These three street railway loop terminals were planned and established by the Buffalo Ry. Co., and we are indebted to Mr. C. G. Lewis, Engineer of Way and Buildings, for much interesting information concerning them, and also for drawings from which our illustrations were made.

As to the maximum number of cars operated through the terminals, the figures of the operating department of the street railway company show that a maximum of 243 cars per hour were passed through the West Terminal (this includes both loops), and a maximum of 130 per hour through the East Terminal. Mr. Lewis states that these figures seem low to him, but he has no records of his own.

The exhibition closed on Nov. 3, and all tracks, buildings, etc., in connection with the East and West terminals were removed by Nov. 25, and the grounds restored to their original condition.

WEST TERMINAL.

Permission was obtained from the Common Council to lay two additional temporary tracks in Elmwood Ave. from Forest Ave. north to Amherst St. These were open tracks, mostly of 60-lb. T-rails, filled in to the top of the ties, except where the conditions of traffic necessitated their being filled to the top of the rail. From Scajaquada Creek north the line was very considerably changed from the already existing lay-out. The original tracks followed the sinuosities of the street, as shown by the dotted line in Fig. 1, but arrangements were made with the various property holders so that a decided straightening of the line was effected.

This terminal was designed to give two entirely distinct systems of track and two loops, so that the East Side and the Elmwood Ave. cars would run to the east loop in the terminal, and the West Side cars to the west loop in the terminal without interfering with each other. The method of operating will be readily seen from Fig. 1, while Fig. 2 gives a detailed plan of the terminal.

Systems of crossovers were placed at various points in the street to provide for emergencies

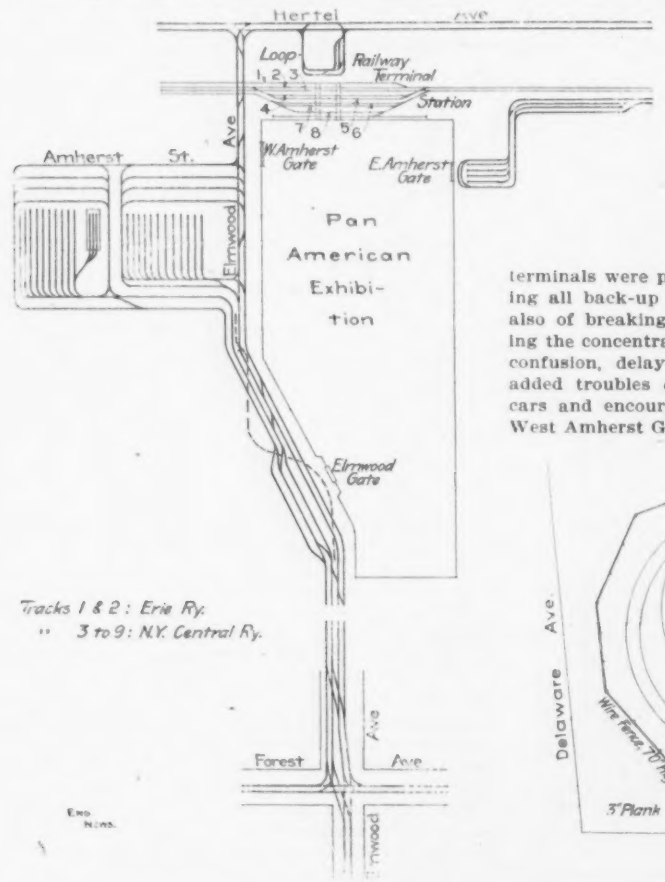

FIG. 1. SKETCH PLAN OF TERMINALS AT THE PAN-AMERICAN EXHIBITION AT BUFFALO.
(This is not drawn to scale.)

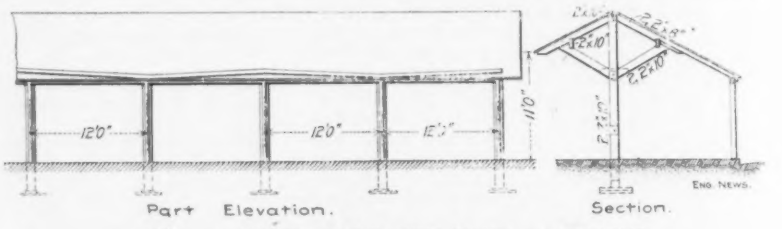

FIG. 4. CANOPY ROOF OVER TRAIN PLATFORMS.

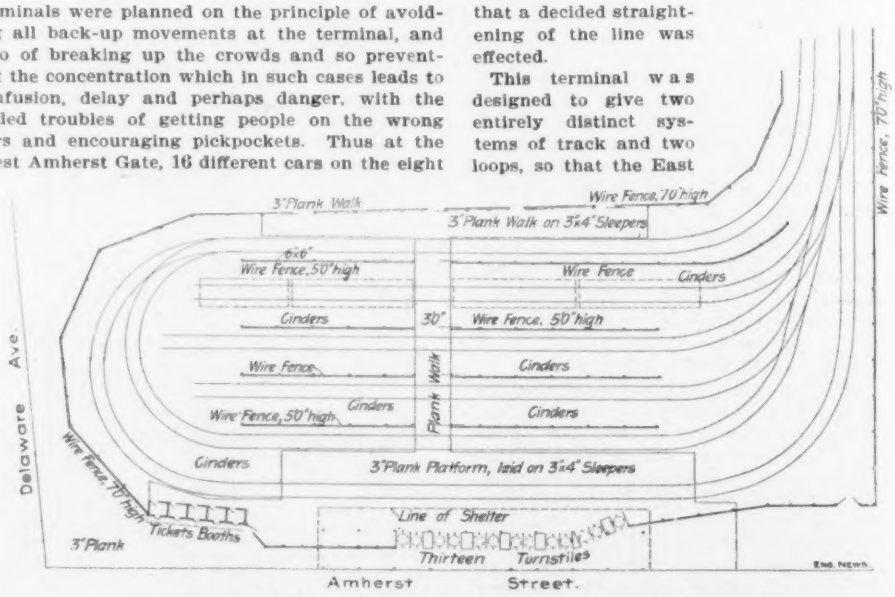

FIG. 3. PLAN OF EAST TERMINAL OF THE BUFFALO RY. CO.

when it might become necessary to temporarily disuse a portion of either loop. The idea followed in the design of the special work was to make all facing point switches of tongue switch pattern so that they could be thrown by the motormen. All

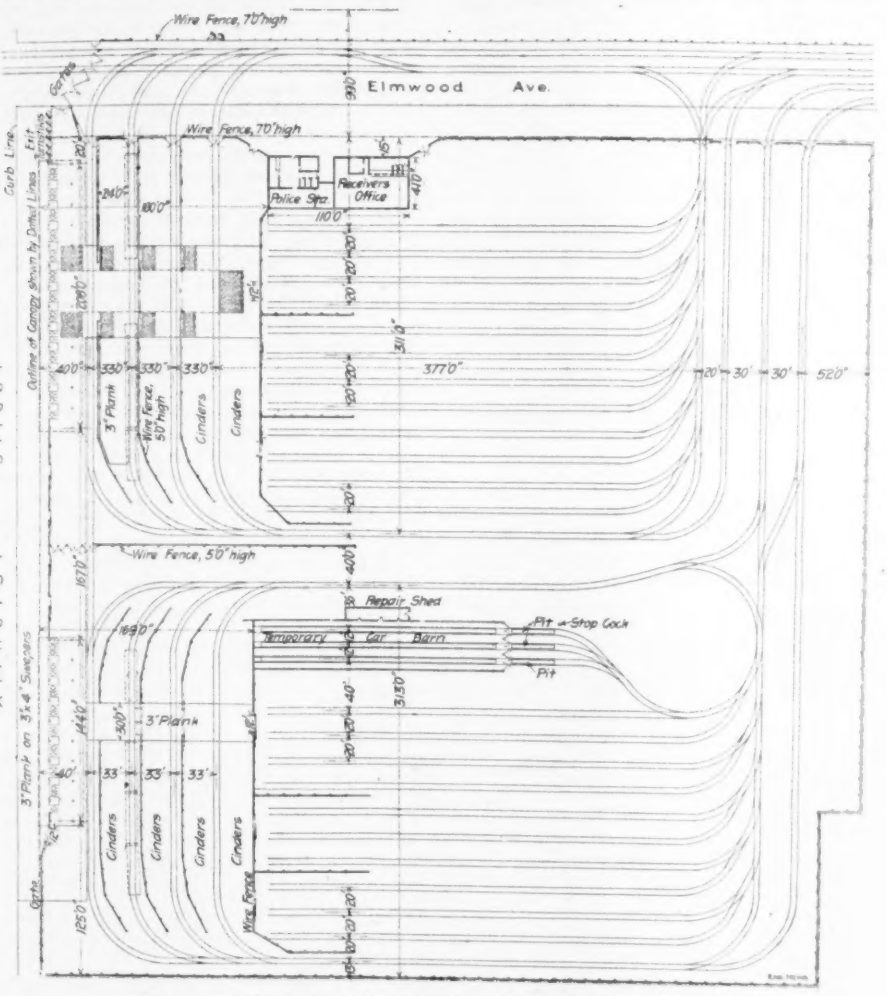

FIG. 2. PLAN OF WEST TERMINAL OF THE BUFFALO RY. CO.

trailing switches were made with split switch points.

The tracks in entering each of the two loops were spread into four tracks, 33 ft. c. to c., parallel with Amherst St., to give increased facilities for unloading and loading. These had tangents about 250 ft. long in the east loop, and 200 ft. in the west loop. The inclosed space in each loop was filled with stub tracks 20 ft. c. to c., about 300 ft. long in the east loop and 360 ft. in the west loop. These were designed both for the purpose of giving room for unused cars during the slack hours, as well as with the intention of taking large crowds away from the grounds during a rush hour, by loading the cars as they stood on the storage tracks and sending them directly to the city. The curves were chiefly of 50 ft. radius, and they were laid to a tight gage of 4 ft. 8½ ins.

Gates were placed across Elmwood Ave., at the south property line of Amherst St., and a fence continued down the east side of Elmwood Ave. to Scajaquada Creek bridge, thus effectually cutting off public access to the terminal. Vehicle traffic was allowed to pass, by keeping a gatekeeper at the gates already mentioned in Elmwood Ave. There was some opposition manifested to this, but it was very slight, as the advantages gained in the handling of the crowds were very apparent.

A building, 40 × 110 ft., was placed in the east loop which served both the purpose of a sub-station for the city police and a receiver's office for the railway company. In the west loop was placed a temporary car barn for three tracks, 12 ft. c. to c., with pits under each track; this was for immediate repairs to cars kept in the terminal.

Each of the two loops was furnished with its own canopy roof, under which was placed a row of turnstiles; there being 25 turnstiles on the east loop and 17 in the west loop. It was found in operation that, with the maximum attendance of 150,000 in one day, this was considerably in excess of the requirements; probably half the number would have been sufficient. A series of seven exit turnstiles were also placed in the west loop close to Elmwood Ave. entrance. Tickets were sold at small booths placed between the turnstiles and the south curb line of Amherst St. The space between the north track of the loops and the south curb line of Amherst St., was planked for the entire width of the terminal, and the spaces between the four loading tracks in each loop were partially planked and partly filled with cinders. Wire fences, 5 ft. high, separated the tracks, and compelled passengers to use the proper crossing, where watchmen were stationed. At the crossing there were sliding gates in the fences; two 16-ft. gates in those of the east loop, and two 12-ft. gates in those of the west loop.

Portable signs and the services of a large number of uniformed attendants assisted passengers in finding their particular cars, while during the homeward rush men with megaphones announced the destinations of the cars as they stopped to load.

At first the cars bound down-town, to the city, were loaded in Elmwood Ave., at the Elmwood Gate, but this gave rise to a very serious trouble, and, after the exhibition had been in operation for a few weeks its use was discontinued after 8 p. m. No difficulty was experienced in unloading at this point, as the crowds came gradually, but in the evening hours when the traffic became heaviest, it was found impossible to stop down-town cars at this point. The exits at the Elmwood Gate were therefore closed at 8 p. m. and passengers were allowed exit to the cars on the West Amherst terminal only.

A maintenance gang, consisting of a foreman and four to six men, as circumstances required, was kept at this terminal continually; it being their business to maintain all tracks in shape from Amherst St. to Forest Ave. Very few derailments occurred, and, with two exceptions, no blockades were caused by these derailments, the delay being only for a few minutes in both cases.

NORTH TERMINAL.

For this terminal it was necessary to obtain the right from the city to allow one track to be laid through Ledger St., south from Hertel Ave.; the rest of the track shown was on private property. Access to the exhibition grounds was had through a subway about 200 ft. long, built beneath the tracks of the steam railway terminal. This subway was the most considerable feature of this terminal in the way of expense. The tracks were laid with T rails, and the details were similar to those supplied in the West Terminal. This loop, Fig. 1, had a single track on the west side, a double track for loading and unloading, and three tracks on the east side.

EAST TERMINAL.

In order to reach the East Terminal, at the East Amherst Gate, it was necessary to construct about a mile of double track from Parkside Ave. to the northeast corner of Amherst and Delaware Aves. The right to place a temporary track in Crescent St. was obtained from the city, and the rest of the track was laid on private right of way. The track was of T-rail construction and the curves and switches were similar in every respect to those laid in the West Terminal. The facilities supplied at the loop were much less than those of the

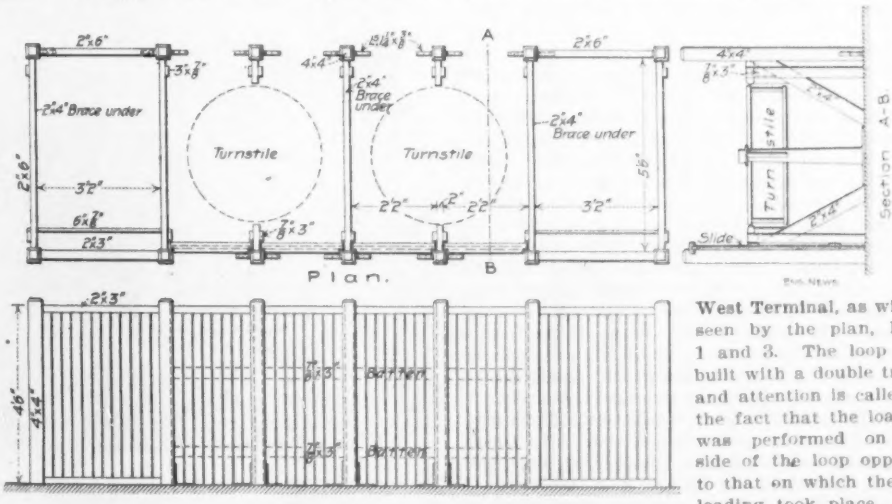

FIG. 5. FENCE CONSTRUCTION AT THE TURNSTILES OF THE STREET RAILWAY TERMINALS.

West Terminal, as will be seen by the plan, Figs. 1 and 3. The loop was built with a double track, and attention is called to the fact that the loading was performed on the side of the loop opposite to that on which the unloading took place. The advantage of this consisted in the fact that there was no interference whatever between the incoming and outgoing crowds, and (comparatively speaking) it had greater efficiency than either of the West Amherst loops, where the loading and unloading were done at one end of the loop. The radius of the inside curve at

the west end of this loop was about 30 ft. after the switches were passed. This was too short to allow the trains to pass around, as the bumpers would interfere; single cars, however, had no difficulty in taking it, and not the slightest trouble was experienced during the season. This curve had double guard rails and was laid to gage ¼-in. wide. This was the only exception to the tight gage track before mentioned; all other curves had single guard rails only.

Fig. 4 shows the construction of the light canopy roof, and Fig. 5 shows the general construction of the fences at the turnstiles through which passengers were admitted to the platform.

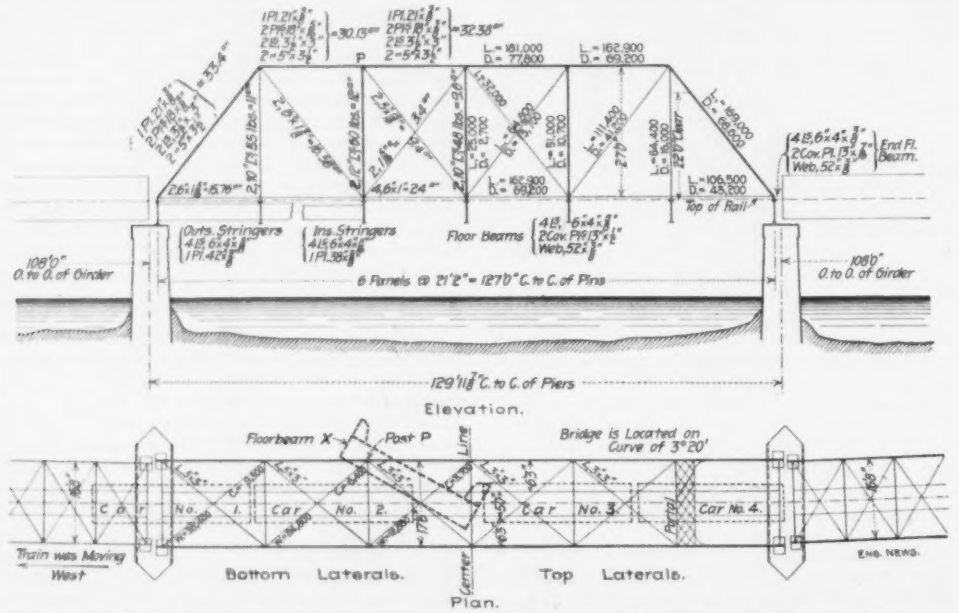

FIG. 1. GENERAL PLAN AND STRESS SHEET OF BRIDGE NO. 24, MEADVILLE DIVISION, ERIE R. R.

FALL OF A RAILWAY BRIDGE NEAR MEADVILLE, PA.

On Oct. 5 the central span of a bridge on which the main line of the Erie R. R. crosses French Creek, at Buchanan Junction, a few miles from Meadville, Pa., fell into the river together with a freight train that was crossing the structure at the time. No one was killed or injured in the wreck. Bridge failures are intrinsically interesting to the engineering profession, and we are therefore glad to be able to give herewith the particulars of the bridge and of the accident, and to show some views of the wrecked structure.

The Buchanan bridge (Bridge 24, Meadville Division, Erie R. R.) consisted of three spans, single track. The two end spans were half-through plate-girder spans, each 108 ft. long out to out; in the center was a through pin-connected truss span 127 ft. long c. to c. end pins. The bridge is on a 3° 20′ curve in the line, to the right going west, but the curve is somewhat flattened over the bridge, so that it is probably less than 3° there. The stress-sheet of the bridge is reproduced in Fig. 1, which also gives the alinement in plan. (The heavy broken lines indicate portions of the train and its loading and will be referred to below.) The stringers of the bridge are riveted into the floor beams, and the superelevation of the outer rail, about 4 ins., is obtained by making the outer stringer this amount deeper than the inner one.

The westbound freight train which was crossing the bridge at the time of the wreck consisted of a consolidation locomotive weighing 145,000 lbs., of which 131,000 lbs. was on the drivers, and 28 cars followed by a caboose. The engine and 20 cars had passed over the bridge when it fell; four cars went down with the bridge and four cars with the caboose remained on the track east of the wrecked span. The station, Buchanan Junction, is about a half-mile east of the bridge, and the train had made a stop there, so that it was not moving at any high rate of speed when crossing the bridge. The cars which fell with the structure were loaded with heavy bridge material for new work at Pittsburg, Pa. The forward two of these cars are of most interest at present. They carried each four plate girders, being the floor beams for a double-track railway bridge. These floor beams were about 30 ft. long and weighed about 15,000 lbs. apiece; they were fitted at their ends with high projecting gusset plates. They were loaded on edge, side by side, and were strapped together at each end with a light metal strap and fastened to the cars at each end with similar straps from near their tops down diagonally to the sides of the cars.

These two cars are shown in their relative position after the wreck in the plan of the structure, Fig. 1, as Car No. 1 and Car No. 2. The two cars behind them, which also fell, are similarly numbered 3 and 4. These cars were loaded with six bridge stringers extending over both cars, the fastening being similar to that noted above. The four cars weighed, average, about 2,400 lbs. per lineal foot of bridge.

The wrecked bridge is shown in Fig. 2, as viewed from its southerly side. The far truss is seen to be mostly under water, as is also the greater part of the four cars and their loading. The near truss is comparatively little deformed, but is broken laterally at its middle panel point. The picture seems to indicate that this truss was pulled down sidewise by the previous failure of the far truss. It will be observed, by reference to the plan in Fig. 1, that the general direction of this failure is toward the inside of the curve of the track. The far or northerly truss is not broken up; at the west portal the top chord appears to have been broken away completely from the portal and end post, and is probably in the water under the cars. The same top chord also appears to have been broken off near its first panel point from the east portal. A further idea of the manner of failure of the bridge may be obtained from Fig. 3, which is taken from the easterly pier, Pier No. 1 in the plan.

Concerning the cause of the wrecking of the bridge, the following may be said: In the plan, Fig. 1, Cars Nos. 1 and 2 are seen to be separated from the following cars by an open space. The floor of Car 2 was found to show marks as from an object sliding diagonally backward. One of the floor beams which had formed the cargo of Car 2 was found in the diagonal position indicated by X in the plan, and the end of the piece was badly battered. The forward end of Car 3 was knocked in completely. No material damage was done to the other floor beams and the stringers on the four cars, and they fell close alongside the cars, as, for instance, in the extreme foreground in Fig. 3. No evidence of derailment previous to failure was found. The appearance of the wrecked bridge after it fell indicates that one of the posts of the northerly truss, quite probably the post marked P in Fig. 1, was knocked out and thus dragged the bridge down. This in connection with the position of the wrecked cars and floor beam X would establish the following as the manner and cause of the failure: The floor beams loaded on Cars 1 and 2 jerked loose from their fastenings, and one of them fell over from its upright position. This jerking loose was caused quite possibly in the stopping and starting of the train at Buchanan Junction. The floor beam that fell over struck post P, and jammed against the car behind, with sufficient force to break the train in two; the shock of the blow and the momentum of the rear section combined were sufficient to buckle post P, and as a result this side of the bridge dropped down vertically, pulling the other truss over sideways by the attached upper laterals.

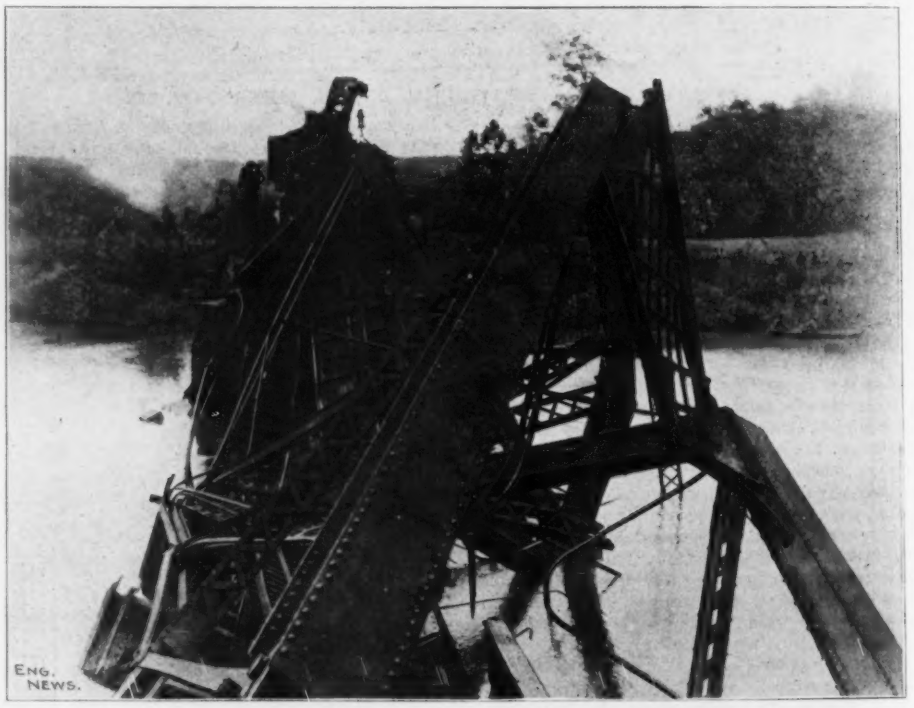

FIG. 2. VIEW OF WRECKED BRIDGE AS SEEN FROM SOUTHERLY SIDE.

The bridge was a comparatively new structure. It was designed and built by the Elmira Bridge

Co., of Elmira, N. Y., in 1893-94, under the standard Erie specifications, and subject to the approval and inspection of the Erie R. R. The material used for the bridge was wrought iron, with the exception of the eye-bars and pins, these being of soft steel. It is interesting to note that the wrecked structure shows very few sheared or broken rivets, the members generally failing bodily. In the falling of the bridge the ends of the stringers rested on the piers, while the floor system was held in line by the lower laterals. Thus an extreme bending stress was put on the stringer system as a whole and upon their connections to the floor beams. As a result the system failed at several points; no complete break was noticed, but at some of the connections the end angles of the stringers split at their roots from the bottom of the stringers almost to the top. The bridge was inspected on June 18, 1902, by the chief engineer and the bridge engineer of the Erie R. R., and was inspected last on September 20, 1902, by the local inspector of the railway.

We are indebted to Mr. W. A. Doane, City Engineer of Meadville, Pa., for the photograph from which our Fig. 2 was prepared. The stress sheet from which Fig. 1 was drawn, and the original of Fig. 3, as well as most of the information given in our text, were courteously furnished us by the engineering department of the Erie R. R. through Mr. C. W. Buchholz, Chief Engineer.

Pier No. 2. Pier No. 1.

FIG. 3. VIEW OF WRECKED BRIDGE AS SEEN FROM PIER NO. 1, AT THE EASTERLY END OF THE BRIDGE.

THE ELECTRIC DUCTS built into the side walls of the New York Rapid Transit Railway are "equipment," according to a recent decision of Justice O'Gorman of the Supreme Court, and being such will have to be paid for by the general contractor, Mr. John B. McDonald. This decision was brought out by an application made some time ago by Mr. McDonald for a writ of mandamus to compel City Comptroller Grout to pay vouchers amounting to $400,000 for work done in constructing electric ducts. Specifically the work that Mr. McDonald wanted pay for was that completed in building vitrified brick conduits in the tunnel up to July 1, 1902. Mr. McDonald contended that the work should be considered as a part of construction. In this contention he was upheld by the Board of Rapid Transit Commissioners and the board's counsel, Edward M. Shepard. The board ordered the bills paid, but when they were presented Controller Grout refused to honor them, asserting that the work should be considered equipment and paid for by the contractors. In his decision Justice O'Gorman upholds the Controller and sharply defines the limitations of the power of the Rapid Transit Commissioners. He says that the legislature has defined as equipment all motors, cars, power houses, real estate on which power houses are built and all devices used in the transmission of power, whether on, near or separate from the railroad. Then the opinion says:

It is clearly the duty of the contractor to supply at his own cost the rolling stock and all means of propulsion. These ducts are no necessary part of the permanent structure. They are concededly to be used for the sole purpose of transmission of power and are an incident to the equipment, nothing more.

If this ruling stands it will mean a cost of about $1,200,000 to the general contractor and, consequently, the same amount saved to the city of New York.

TESTS IN COALING VESSELS AT SEA by means of the Lidgerwood-Miller Marine Cableway were made on the Russian battleship "Retvizan" on Sept. 12, 1902, in the Baltic Sea, near Cronstadt, Russia, under the direction of a Board of Inspectors appointed by the Russian Government. Among the members of this board were Admiral Nikowof, Chief of Testing Squadron, and Rear-Admiral Virenius, Chief of the Bureau of Navigation. The marine cableway on the "Retvizan" is operated by two electric winches, but is otherwise of the construction described in Engineering News of April 3, 1900. In making the test coal was transferred from the auxiliary cruiser "Asia," which acted as a collier, and was taken in tow by the "Retvizan." The entire marine cableway was rigged up in about an hour. The distance between the masts was 400 ft. and the test began by transferring a load of one bag of 350 lbs. Two bags were then sent across at one time and the number finally increased to four bags. The four bags held 1,400 lbs. and traversed the distance between the vessels at the rate of one load a minute. This would show a capacity of 37 tons per hour. As the "Asia" did not have any winches on board the coal had to be hoisted to the masthead by hand and hence the coal did not come over as regularly as it otherwise would. At the time of the trial the vessels were only moving at the rate of 5 knots an hour and the tension of the main cable supporting the load was only about three tons. It is considered that if the speed had been enough greater or a larger sea anchor had been used to make the tension on the main cable eight tons, loads of one ton could have been transferred in the same time, and with no added effort on behalf of the electric winches. Captain Stchensnovitch, commanding the "Retvizan," who was present at the test, endorses the marine cableway in a recent communication to the inventor, as follows: "Witnessing this last success, I am sure that your system of coaling at sea will be adopted by all navies of the world." The trial board reached the conclusion "that the marine cableway works entirely satisfactory and is well worth adopting for general use on board war vessels. All details of the apparatus are well worked out, practical and expedient."

THE PRODUCTION AND USE OF NATURAL GAS in the United States for 1901 is given in press bulletin T 71, as compiled by Mr. Charles D. Walcott, Director United States Geological Survey. Value of gas, $27,067,500, which at 15 cts. per 1,000 cu. ft., is equivalent in heat effect to 8,456,600 tons of coal at $3.20 per ton, assuming 20,000 cu. ft. of natural gas equal to one ton of coal. This is an increase in production of 14% over the preceding year. There were 10,297 wells at the close of 1901, supplying fully 1,000,000 domestic fires, 5,742 manufacturing plants, including 102 iron and steel works, and 219 glass works.

FREIGHT MOVED THROUGH CANALS at Sault Ste. Marie will amount to 35,000,000 tons for this year, as compared with 28,000,000 tons last year, and 8,800,000 tons ten years ago. By far the greater portion of this freight is iron ore, and it is interesting to note in this connection that the estimated output of iron ore from the Lake Superior districts is estimated at 25,000,000 tons for this year.

A SURVEYOR'S TAPE REEL upon which a steel tape 500 ft. long may be wound has been patented and is for sale by J. E. Chapson and V. G. Hills, of Cripple Creek, Colo. A rolling friction is applied to the tape when winding or unwinding, so that the tape is always firmly held, and can not uncoil or spring off the reel. The reel and tape may be suspended with a strap from the chainman's shoulder while measurements are being taken, and altogether the reel presents many decided advantages where a long tape is to be used.

THE LIERNUR PNEUMATIC SYSTEM of sewage removal was installed on a small scale during the past summer at Stansted, Essex, England, by Liernur's English Syndicate. This being the first installation in England, the syndicate did the work at its own expense, but the parish council will "take over" the system after two years if it meets the approval of the Local Government Board. Stansted is "a scattered village in a hilly district." The installation is described as follows in the London "Surveyor" of Oct. 10:

The pumping station—with its receiver, vacuum pump, and gas engine—is in the lowest part of the village, the sewage being conveyed there by a network of 4-in. iron pipe about one mile long, with another mile of house connections. The receiver and pipes are kept in a constant state of partial vaccum, so that there is a steady flow, but the full vacuum (about one-fifth of an atmosphere) is applied for ten minutes every morning, which completely clears the house receptacles and sewer pipes, leaving them clean and dry. There is no need for special flushing, disinfecting the manholes, or ventilating shafts. The work of laying the sewers was carried out by Mr. E. T. Watts, Surveyor to the Stansted Rural District Council, who stated that he was perfectly satisfied with the working of the system, which gave him no trouble. He calculated that the cost would be about 25 cts. per head of population per year.

THE STEAM TURBINE—ITS COMMERCIAL ASPECT.

By Edward H. Sniffen.

Before recurring to actual experience, it may be instructive to consider for a moment the general character of the turbine as a type of motor, contrasted with the piston engine. The steam entering the governor valve passes first a set of stationary blades, then it impinges on the moving blades, driving them around. While the temperature of the inlet end of the turbine is that of the live steam, the exhaust end, only 3 or 4 ft. distant, is cool enough (126° F., when the condenser is working) that one may bear the hand upon it.

The blades each receive a pressure of only one ounce.

In 1897, the Newcastle & District Electric Lighting Co. (England), operating eleven Parsons steam turbines of 75 to 150 KW. each, showed the cost of repairs and renewals of their entire plant, including turbines, generators, boilers, condensers, pumps, fittings, cables, etc., to be only a trifle more than ¼ ct. per KW. per annum.

THE WILMERDING PLANT.—In this country the steam turbine is now operating in several plants. The first prominent installation was at the Westinghouse Air Brake Co.'s works, at Wilmerding, Pa., where the first unit was started in August, 1899; two more shortly after, and the fourth unit in April, 1901. The plant operates regularly eleven hours a day, the service being electric power and lighting.

As the results of a week's test run on the turbines and the steam engines that had been displaced by them, it was found that a saving of coal averaging 36% existed in favor of the steam turbines; and the saving in feed-water averaged about the same percentage. This meant a saving of about 20 tons of coal every 24 hours. The plant comprises four 400-KW. units, occupying a space 45 × 61 ft., in a room 20½ ft. high, and since its installation has run without interruption or visible wear.

THE STAMFORD PLANT.—The Yale & Towne*

*Abstract of a paper read at the annual convention of the American Street Railway Association.

Mfg. Co., at Stamford, Conn., have one 400-KW. steam turbine, furnishing a 240-volt, 2-phase current at 7,200 alternations. It began running Feb. 1, 1902, operating ten hours daily. Up to date its mechanical operation has been most satisfactory.

THE HARTFORD PLANT.—The Hartford (Conn.) Electric Light Co. have one 1,500-KW., 2-phase, 2,400-volt, 60-cycle, turbo-generator, which was started in April, 1901. It is at present the largest plant of the kind in this country. It is used but one or two days a week to relay the water power. When first installed some time was spent in correcting minor defects, since which the plant has given perfect satisfaction.

STEAM TURBINE EFFICIENCY.—Brake tests on a 400-KW. turbine having a rated load of 600 B. H. P. showed a steam consumption of 14.5 lbs. per HP. per hour at full load, to 16 lbs. at half rating, and to less than 19 lbs. at one-quarter capacity. This 14.5 lbs. of steam per brake HP. per hour corresponds to less than 13¾ lbs. per I. HP.

In a recent instance, a result of 11.7 lbs. of steam per electric HP. per hour was guaranteed on a 750-KW. turbine, corresponding to about 10.2 lbs. per I. HP., which is within the ability of few piston engines of much larger size.

The turbine at Hartford, under tests conducted by Prof. Robb, at an average load of 1,800 KW., with 155 lbs. of steam pressure, 27 ins. vacuum and 45° superheat, gave a result of 19.1 lbs. of steam per KW. hour, which is equivalent to about 11.5 lbs. per I. HP.

A test on a 400-KW. turbine at Wilmerding shows 16.4 lbs. of steam per electrical HP. per hour at full load, and 18.2 lbs. at half load, with 125 lbs. steam pressure and 26 ins. vacuum.

Tests made by Prof. Ewing on an English plant (500 KW.) a year after installation showed no material loss of efficiency. At installation it showed 24.1 lbs. steam per KW. hour, a year later it showed 25 lbs. under more difficult conditions.

FLOOR SPACE AND FOUNDATIONS.—The floor area of a turbine is about ⅔ that of a vertical engine and about ⅖ that of the horizontal, for a 1,000-KW. unit, including the generator. Figuring the foundations at 15 ft. deep to give space underneath for condensers, etc., the turbine has a great economic advantage; but it has a still greater advantage when foundations are made only to support and steady the engines, for a turbine has so little vibration that it does not even require foundation bolts. Figured on actual foundation volume required, a 1,000-KW. turbine requires only 1-9 that of a vertical engine and 1-15 that of a horizontal.

As ordinarily built, assuming $7 a cu. yd. for concrete foundation, the 1,000-KW. turbine foundation costs $0.50 per HP., the vertical engine about $1.50, and the horizontal about $2.50 per HP., all three being figured 15 ft. deep to provide condenser space.

Assuming 15 cts. per cu. ft. of space inside the walls as the cost of a brick building with steel roof trusses and fireproof covering, the cost of a building for the turbine plant is about half that for either horizontal or vertical engine. Land for building sites in cities is a large item. The turbo-generator requires about ½ sq. ft. per KW.

SUMMARY.—The larger field for the turbine begins about where the high-speed piston engine leaves off, and the low-speed engine begins. It is especially applicable to service of medium and large size units on account of the economies in steam, in floor space, foundations and buildings.

The turbine can use superheated steam of any feasible temperature, because there are no internal rubbing surfaces, no glands, and no cylinder oil to cause lubricating troubles.

The exhaust steam being uncontaminated with oil yields pure distilled water, a condition of great moment where water is scarce or contains impurities that injuriously affect the boiler. Its speed, of course, prohibits belt drive, so that its chief field will be in generating electricity.

DISCUSSION.—The reading of the paper was followed by a long discussion.

Mr. John I. Beggs, of Milwaukee, said that his company had for two years postponed changes in their plant, involving three or four million dollars, pending the development of the steam turbine in practice. He asked Mr. Sniffen whether his company would furnish a steam turbine separate from the generator, for the speed of the turbine (750 revs. per min.) so greatly reduced the size of the generator as to effect a large saving in the cost of the generator, and he wished to know whether the manufacturer expected to reap all the benefit of that saving.

Mr. Sniffen said that Westinghouse, Church, Kerr & Co. would not sell turbines and generators separately; they would be sold as a unit, for they could not be made by different manufacturers and put together by the purchaser so as to give satisfaction.

Mr. Heft asked whether the life and efficiency of the turbo-generator would be guaranteed.

Mr. Sniffen replied that the efficiency would be guaranteed.

Mr. Beggs said that his chief engineer had visited all the turbine plants in the country. What the turbine in large 5,000-KW. units will do is yet a matter of conjecture, although several such are being built for a company in Chicago, the efficiency of which he is waiting to see.

Mr. C. O. Mailloux stated that so far as his investigations had disclosed, the cost of a condensing apparatus for the steam turbine is somewhat larger than for the ordinary engine, largely because the exhaust pipe is larger. This is offset by many other advantages. He could see no reason why steam superheated to a point that would make the steam turbine cherry red would interfere with its working. One of the difficulties of the steam turbine to-day is not mechanical, but electrical. The turbine cannot be used with direct-current generation; it requires an alternating generator. While the generator now used makes considerable noise, this will doubtless be remedied.

Mr. Sniffen said that his company is building four 4,000-KW. turbines; three 1,250-KW. turbines for the Rapid Transit Subway in New York to be used for lighting; three 3,500-KW. units for the Metropolitan Railroad of London; two 1,000-KW. units for the De Beers Co. of Kimberly, Africa, and other large units. These last-named are to be tested by Prof. Thurston before shipment.

DOUBLE ARCH SPAN ELECTRIC RAILWAY BRIDGE OVER THE VERMILLION RIVER, AT BIRMINGHAM, O.

The Osborn Engineering Co., Cleveland, O., Designers; Canton Bridge Co., Canton, O., Builders.

STEEL ARCH ELECTRIC RAILWAY BRIDGE OVER THE VERMILLION RIVER AT BIRMINGHAM, O.

We illustrate in the accompanying cut steel arch bridge to whose neat and attractive appearance additional interest is lent by the fact that it was constructed for interurban electric railway service and is significant of the high-class permanent construction now practiced on many such roads. This bridge was built to carry the Oberlin-Norwalk extension of the Cleveland, Elyria & Western Ry. over the Vermillion River at Birmingham, O. The site of the bridge being a spot of great natural beauty it was felt that a structure should be built whose appearance would be in harmony with its natural surroundings, and an arched truss seemed most fitted to meet this demand and at the same time be an economical structure. Accordingly an arch bridge of two equal spans was designed, as shown by the illustration.

Briefly described, the bridge consists of two arches, each having a span of 164 ft. c. to c. of end pens, flanked by a plate girder span of 40 ft. at each shore end. The rise of the arch spans is 37 ft., and the total length of the bridge, including end spans, is 423 ft. Its height above the river bed is 62 ft. The arches are of the three-hinged, spandril braced type, all connections of the main members being pin connections. The depth of the arch trusses is 42 ft. at the ends and 5 ft. at the crown. The trusses are placed parallel to each other and 15 ft. apart. They carry a steel floor system in the plane of the top chord. The structure was designed to carry a train of coal cars of 80,000 lbs. capacity.

The foundations are all carried to the hard blue shale rock which lies at about the elevation of the river bed and is exposed on the sides of the river valley. The abutment piers, or skewbacks, are in pairs, there being an independent structure for each shoe. These skewbacks are set well back into the shale to avoid any possibility of the foundation backing being destroyed by disintegration of the rock, which takes place rapidly upon exposure to air. The center pier is a heavy piece of masonry, 18 × 36 ft. on its base and 23 ft. high above its bed and 14 ft. high above the ground line, the elevation of the shoes being just high enough to clear the high water level. This center pier is able to withstand the thrust of either of the arches in case the opposing arch be removed. A feature of this pier is the large skewback stones, each 2 ft. 9⅞ ins. thick, 6 ft. 6 ins. long and 3 ft. 9 ins. wide, and weighing 3½ tons. The pier has a cut-water on its upstream end. The sandstone for the substructure all came from the Kipton quarries of the Cleveland Stone Co., five miles distant from the bridge site, and was hauled to the site by teams. The measurements for dressing the faces of the piers were made with a 200-ft. steel tape, which was compared with the 100-ft. standard bar at the Case School of Applied Science. Spring balances were used in making the measurements, and the proper allowance made for the stretch of the tape. The tapes used by the inspector in the shop were compared with this same standard, in order to avoid any error due to differences in length of tapes.

The spans were erected upon falseworks resting on piles driven to rock. Erection began at the abutments and was carried toward the center from the ends, and after the spans were swung free of the falsework it was found that the camber was just what it was designed to be, proving that there was no sensible error in the measurements. The paint used was Detroit Superior Graphite, the final color being green.

The bridge was designed by, and its execution superintended by the Osborn Engineering Co., of Cleveland, O., Wilbur J. Watson, Assoc Mem. Am. Soc. C. E., Bridge Engineer. The substructure was built by Messrs. Gallup & Coe, and the superstructure was built by the Canton Bridge Co., of Canton, O. Mr. A. G. Jenkins was in charge of erection for the bridge company.